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RDC TR-59-72

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[redacted]OOST GLIDE

WEAPON SYSTEMS

APPLICATIONS

STUDY

311156L

JUNE 30, 1959

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Boost Glide Weapon

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PREPARED BY ____ 6/23/59

SUPERVISED BY ____

APPROVED BY ____ 6/26/59

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(U) BOOST GLIDE WEAPON SYSTEMS APPLICATIONS STUDY

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June 30, 1959

DIRECTORATE OF SYSTEMS MANAGEMENT
HQ AIR RESEARCH AND DEVELOPMENT COMMAND
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IV. MULTI-ORBIT SYSTEMS

This class of vehicles includes those which remain in orbit for a day or longer and the vehicles that might be used to re-supply orbiting vehicles with relief crews, food and other expendables.

Since the vehicles proposed are those which might be made operational in the 1965 - 1970 time period, they are limited to those which can be assembled on the earth and propelled into space as a unit. It is believed that it will become feasible to send up re-supply vehicles to satellites; but, the assembly of large satellites in space will be only in the exploratory stage in this time period.

Prior to proof of the feasibility of mating satellites and re-supply vehicles in space, there will be applications for manned satellite vehicles. Vehicles with satellite periods of 14 days and one month have been configurated.

A. ORBITAL RECONNAISSANCE VEHICLE, 14 DAY, MANNED

1. Operational Concept

The Manned Orbital Reconnaissance system uses a recoverable orbiting vehicle operating on a 14-day mission cycle. The three man crew, in conjunction with the vehicle and its installed subsystems, performs reconnaissance functions which are unsuited to unmanned automatic operation.

The reconnaissance objectives and their associated sensors are:

(a) Imminence of hostilities -- photo, radar, infrared (IR) and electronic intelligence (ELINT).

(b) Ballistic missile early warning -- IR.

(c) Targeting -- photo, radar, IR.

(d) Electronic order of battle -- ELINT.

(e) Technical intelligence -- photo, radar, IR, ELINT.

(f) Post-strike surveillance -- photo, radar, IR, ELINT.

Three methods are provided for getting reconnaissance information back to the ground command station. In the case of technical intelligence, electronic order of battle, and targeting data, information is brought back when the vehicle lands. This is the most dependable way to get high resolution data back with the least system degradation.

Another method provided for getting information back is a broadband data link used to "read-out" a photo or tape from the vehicle to the ground. This is a line-of-sight system used only over the United States.

The highest priority messages concerning early warning or imminence of hostilities use a secure global HF data link. The data rate is low, but so is the vulnerability to jamming and detection by the enemy.

Operationally, nine vehicles will be put into each of three equally spaced

circular polar orbits at an altitude of 150 N. miles. This number will be continuously maintained by both launching and recovering two vehicles per day. Vehicle position is always known to an accuracy of 1 mile through the use of celestial-inertial guidance, corrected periodically, by inputs from known fix points. The vehicles are tracked from the ground once or twice every day by radar tracking stations in the United States. Two launching and landing bases in the United States are used. The pilot can de-orbit for landing at any time the situation may warrant it.

Vulnerability of the vehicle and crew is reduced by using countermeasures consisting of ten orbital decoys per vehicle which are launched individually with random spacing into the same orbit. The decoys are designed to look like and behave like the vehicle, but they do not simulate the radar transmission.

An overlapping coverage of the Soviet complex by infrared ballistic missile detection is provided by the early warning equipment as shown in Figure IV.A-1. A vehicle will have essentially unity probability of detecting any ballistic missile fired within the 1500 nautical mile radius circle surrounding that vehicle.

The coverage of the other sensors is shown in elevation and plan views on Figure IV.A-2. This is representative of a typical loading. Some of the coverages -- notably photo optical -- vary widely with equipment used. The optical and IR equipments are not restricted to looking straight down as shown in the Figure, but can be directed at targets of interest on either side of the vehicle.

The personnel aboard the orbital reconnaissance vehicle contribute in the areas which cannot be adequately covered by unmanned systems. The men make

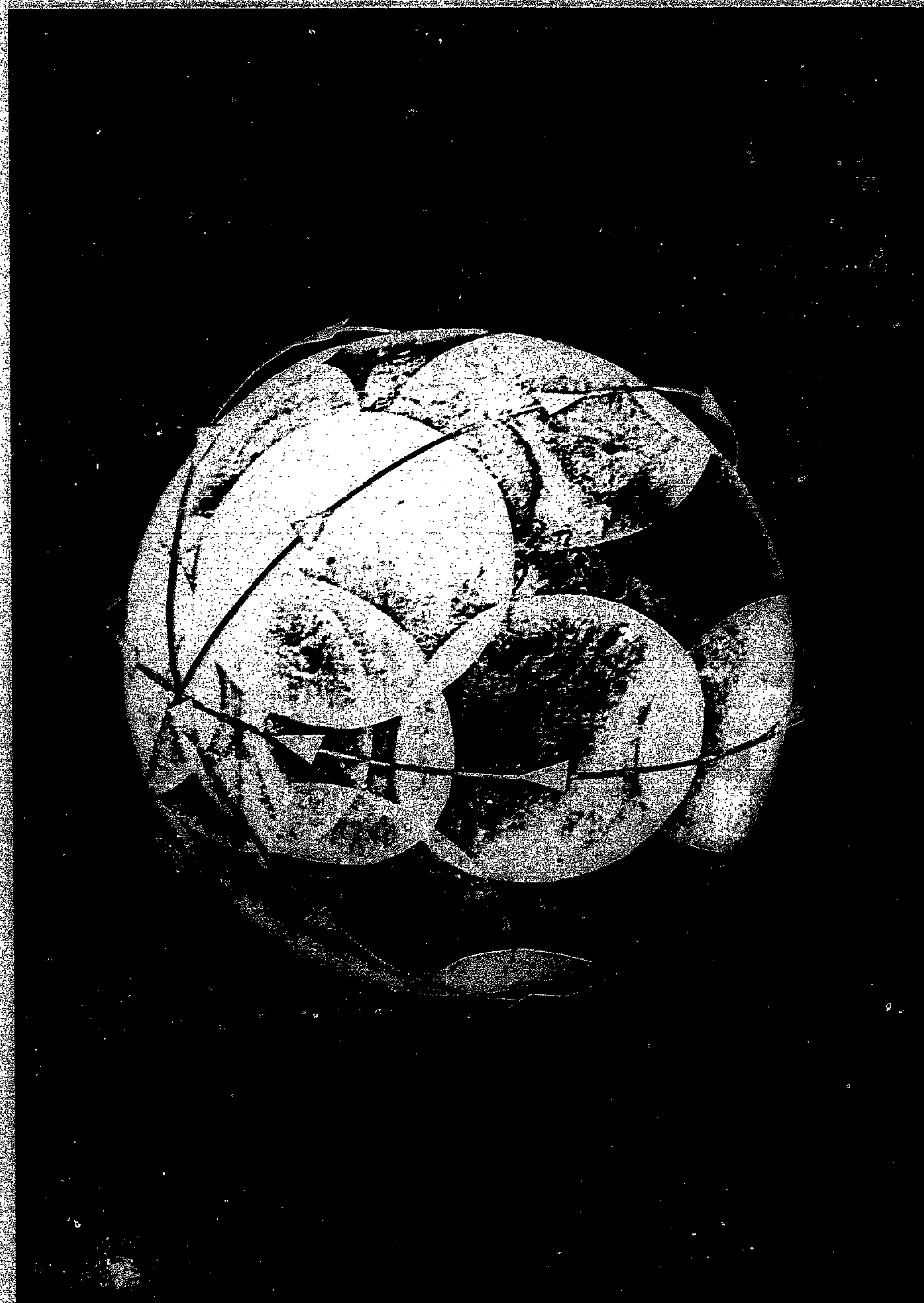

FIGURE IV.A-1

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ELEVATION AND PLAN VIEW OF RECON.

SENSOR COVERAGE

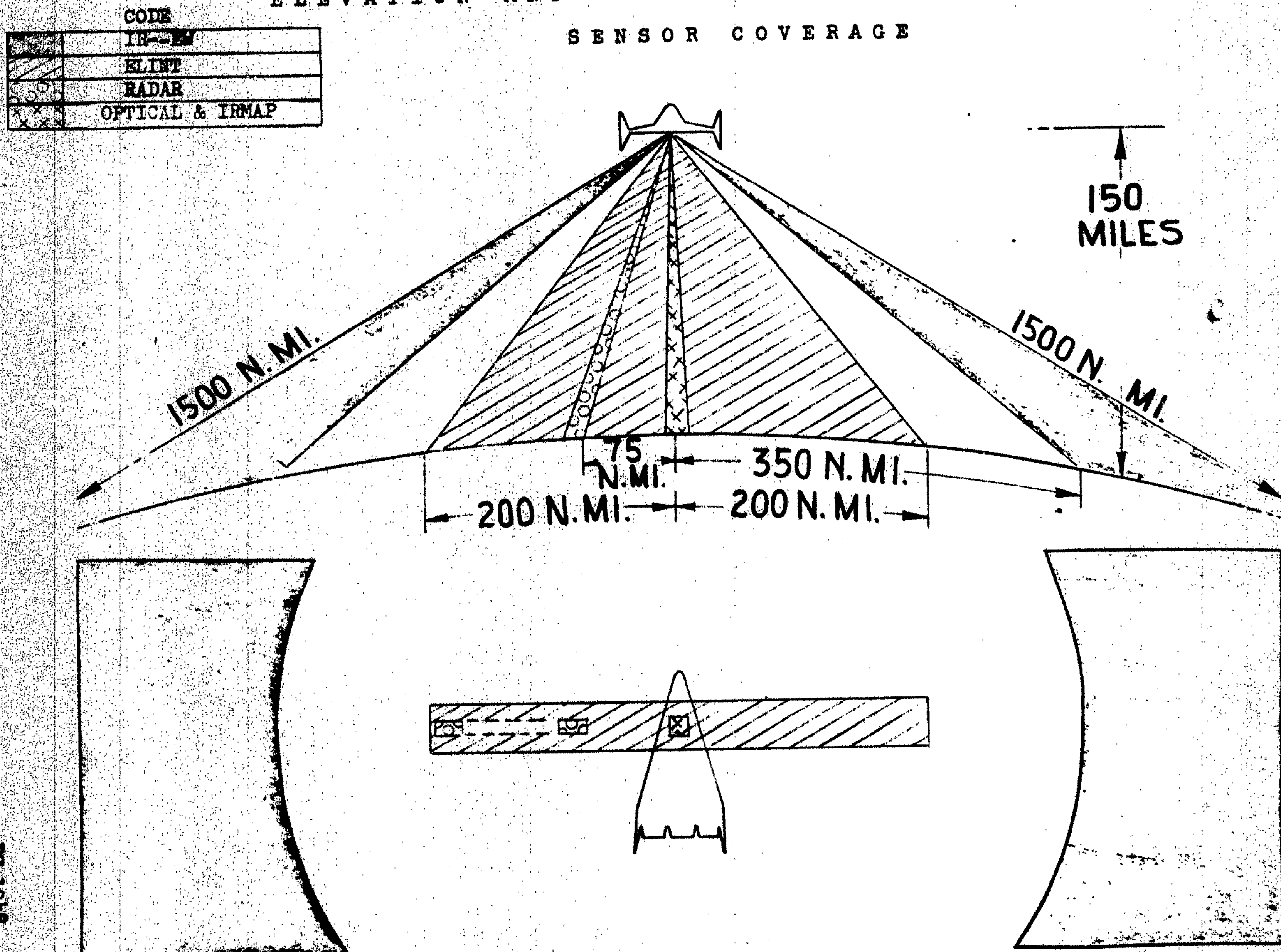


Figure IV A-2

Rev. 12-8-58
Rev. 3/23/59

certain adjustments to improve reliability of equipment. They select alternate modes of operation to compensate for system degradations beyond the ability of the crew to repair. They make decisions as to mode of operation required under unusual reconnaissance conditions.

The crew members possess the capability for rapid processing and evaluation of certain types of data for limited consideration. They do this in a way that would be very difficult to duplicate in a computer. An example of this is a ballistic missile warning system. A satellite equipped with infrared indicators can be instrumented to sound an alarm when a bright spot is seen, but a man can interpret this information and act as a data filter. He can make a decision to alert the U.S. when he decides that the bright spots on the screen are tracks of ballistic missiles heading toward the U.S. This function involves path form recognition and false alarm rejection.

Another important contribution of the man in the reconnaissance system is in evaluating imminence of hostilities data. Whereas the large bulk of reconnaissance information received is stored for physical return to base, the crew can receive instructions from home on each pass over the zone of interior to thoroughly examine a few small areas on the next pass over the Soviet complex. By comparing the fresh data with the stored data from the vehicle catalog, the crew is able to assess some imminence of hostilities criteria and immediately notify home base.

The human decision capability given in the examples above, as it applies to identification, alerting, evaluating and handling unusual situations, offers the real basis for the requirement for a manned reconnaissance system.

The disadvantages of a manned system are the additional costs of system design and operation resulting from having a human aboard the vehicle. A

man is vulnerable to a number of factors involving enemy action, environment, and radiation intensities. These disadvantages are outweighed by the advantages of manned operation cited above.

2. System Configuration

a. Configuration and Performance

Two vehicle configurations and inboard arrangements are shown in Figures IV.A-3, IV.A-3a, IV.A-4, and IV.A-4a. Principal differences in these two configurations are concerned with the use of particle shield and combination solar contactor on the first vehicle while the other configuration employs a chemical powered APU. The second vehicle also has some differences in the internal arrangement.

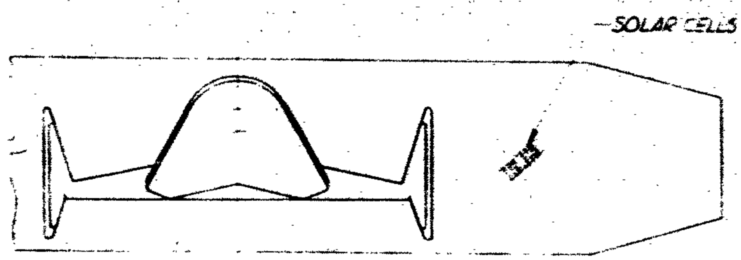
(1) Orbital Reconnaissance Vehicle with Particle Shield

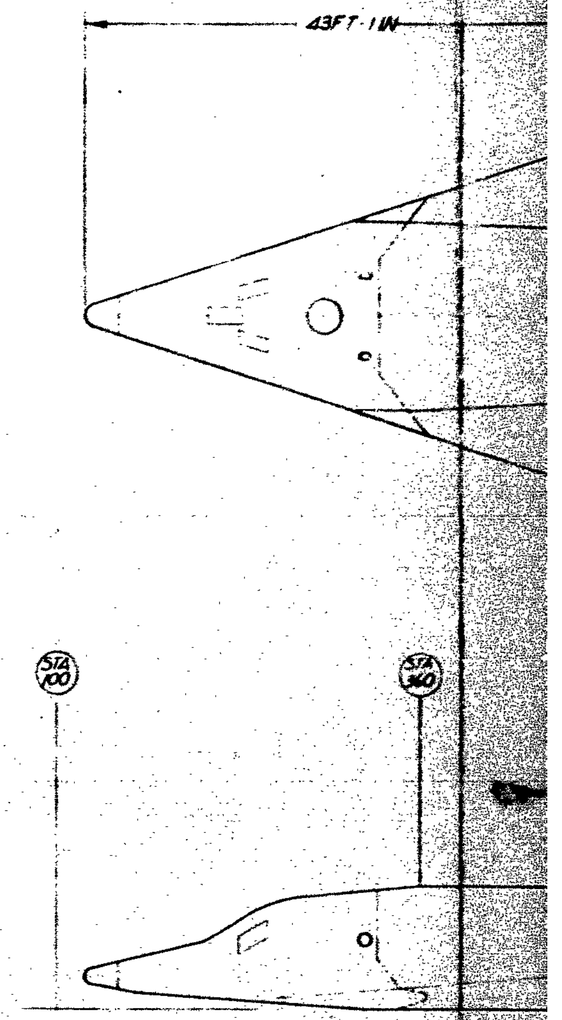
Vehicle configuration and inboard arrangement are shown in Figures IV.A-3 and IV.A-4.

The Orbital Reconnaissance Vehicle is a larger version of DS-I, evolving from the single manned, single orbit DS-I concept to a multi-manned, multi-orbit mission. The mission objectives and orbiting time of 14 days are the primary factors determining the vehicle configuration. Analysis of the mission and of the equipment to be operated indicates the need for a minimum crew of three.

This vehicle will be launched in a "[illegible]" trajectory such that recovery can be effected without exceeding skin material temperature limits in case of premature thrust termination.

An orbiting altitude of 150 miles is selected as consistent with the missile detection range requirements and detec-





MANNED ORBITAL RECONNAISSANC
814-3009

FIGURE IV A

1

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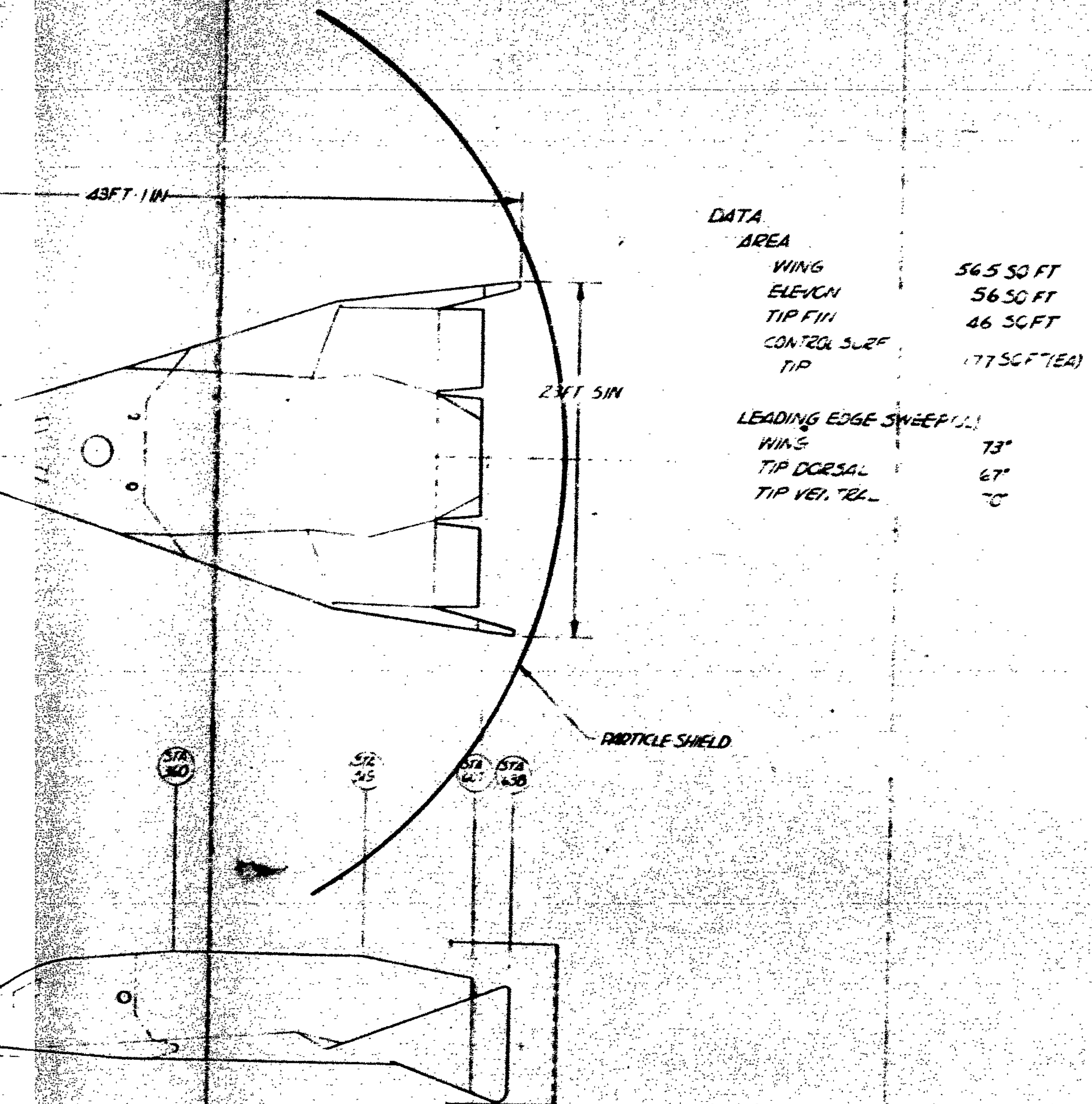


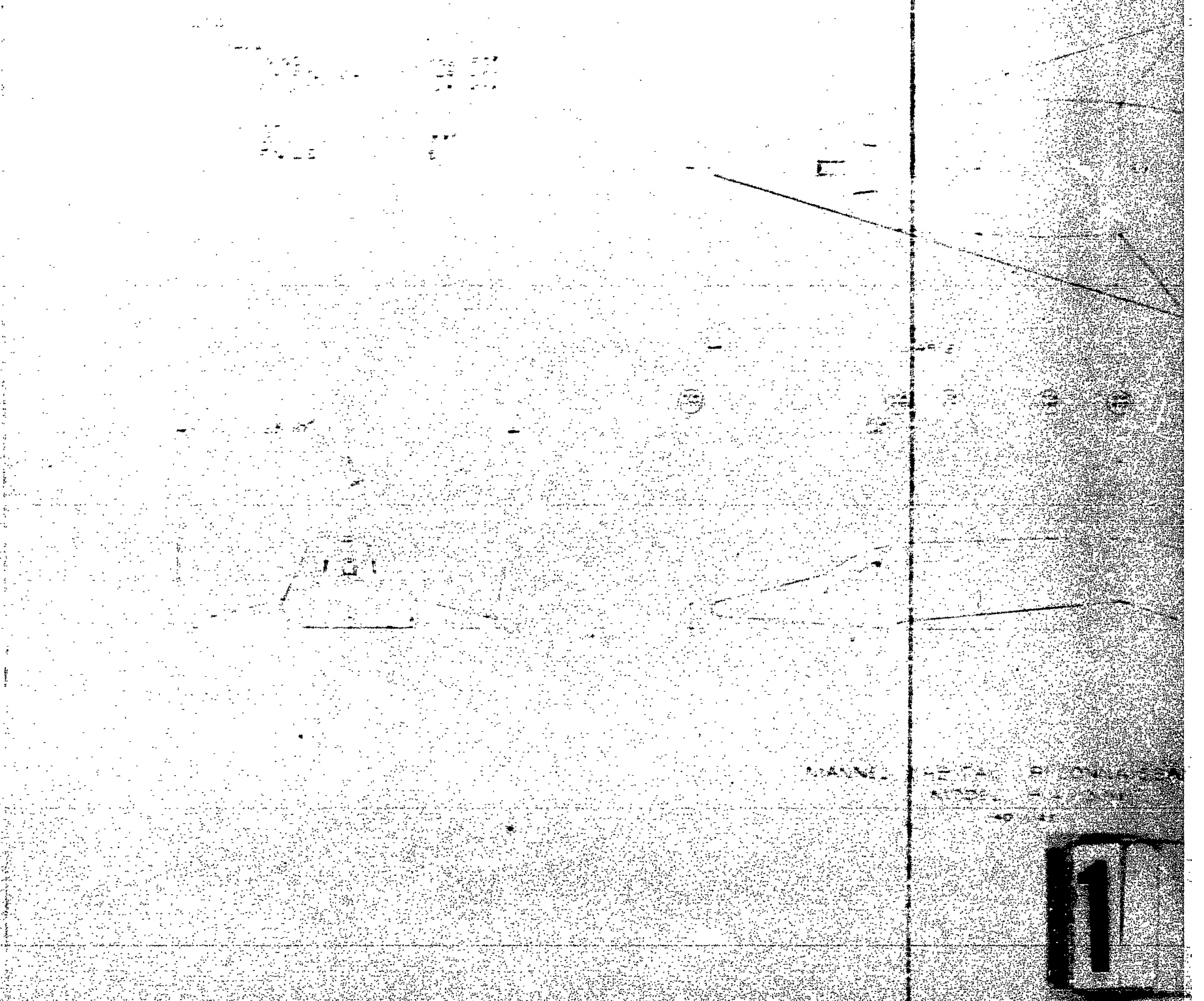
...NED ORBITAL RECONNAISSANCE VEHICLE
814-3009

FIGURE IV A 3

SECRET

GENERAL ARRANGEMENT
MODEL
814-3009
73-7773

SECRET



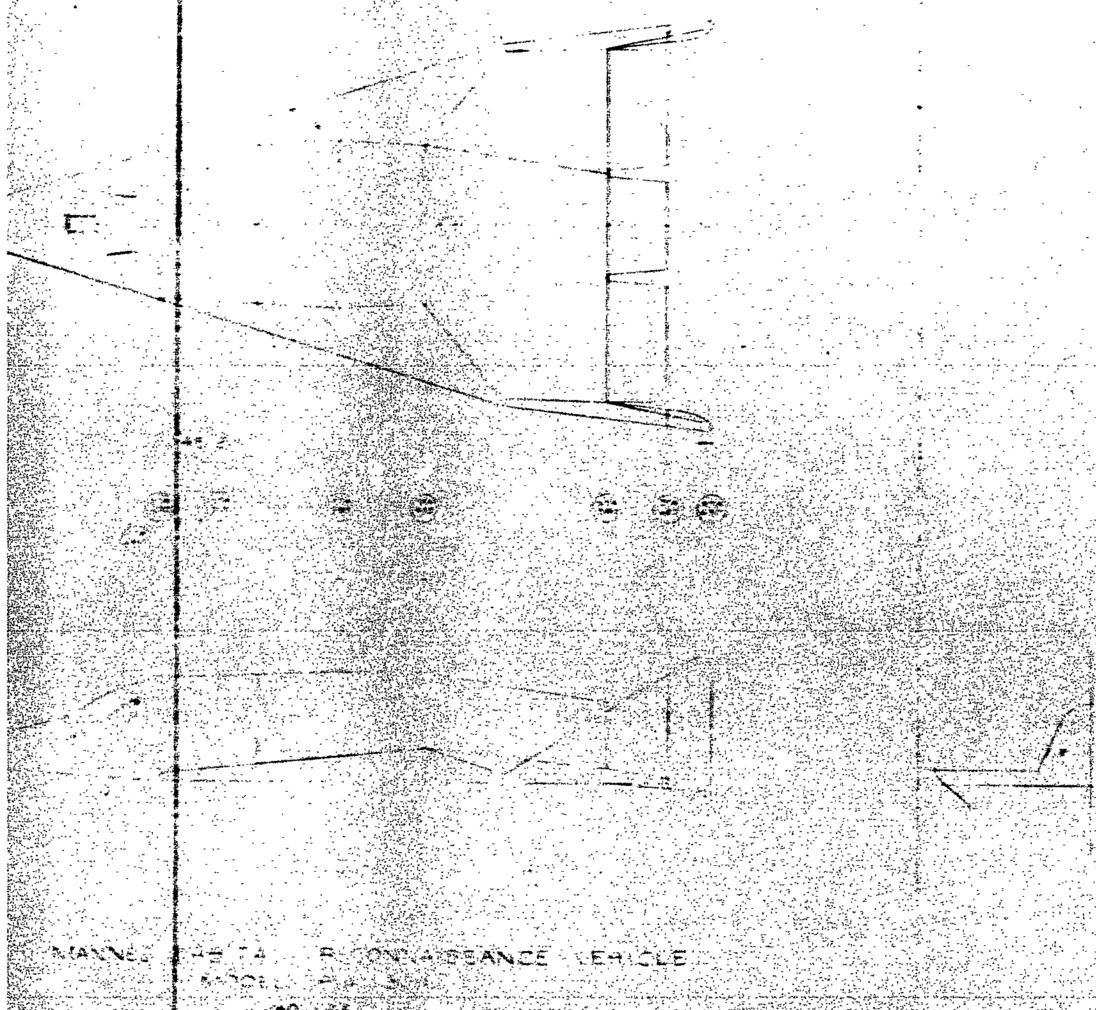
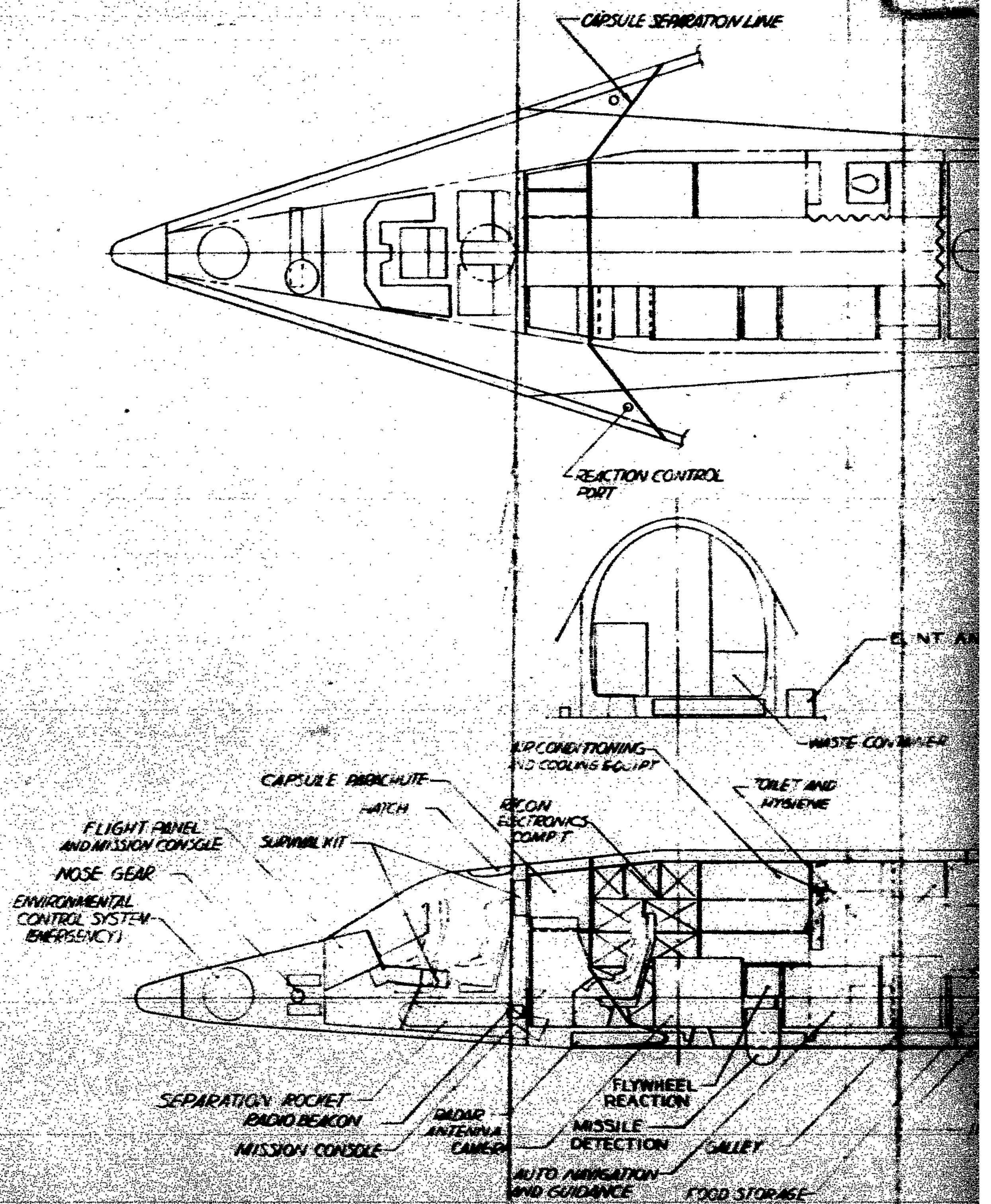


FIGURE IV.A-3a



MANNED ORBITAL RECONNAISSANCE VEHICLE
814-3009

FIGURE IV A.4

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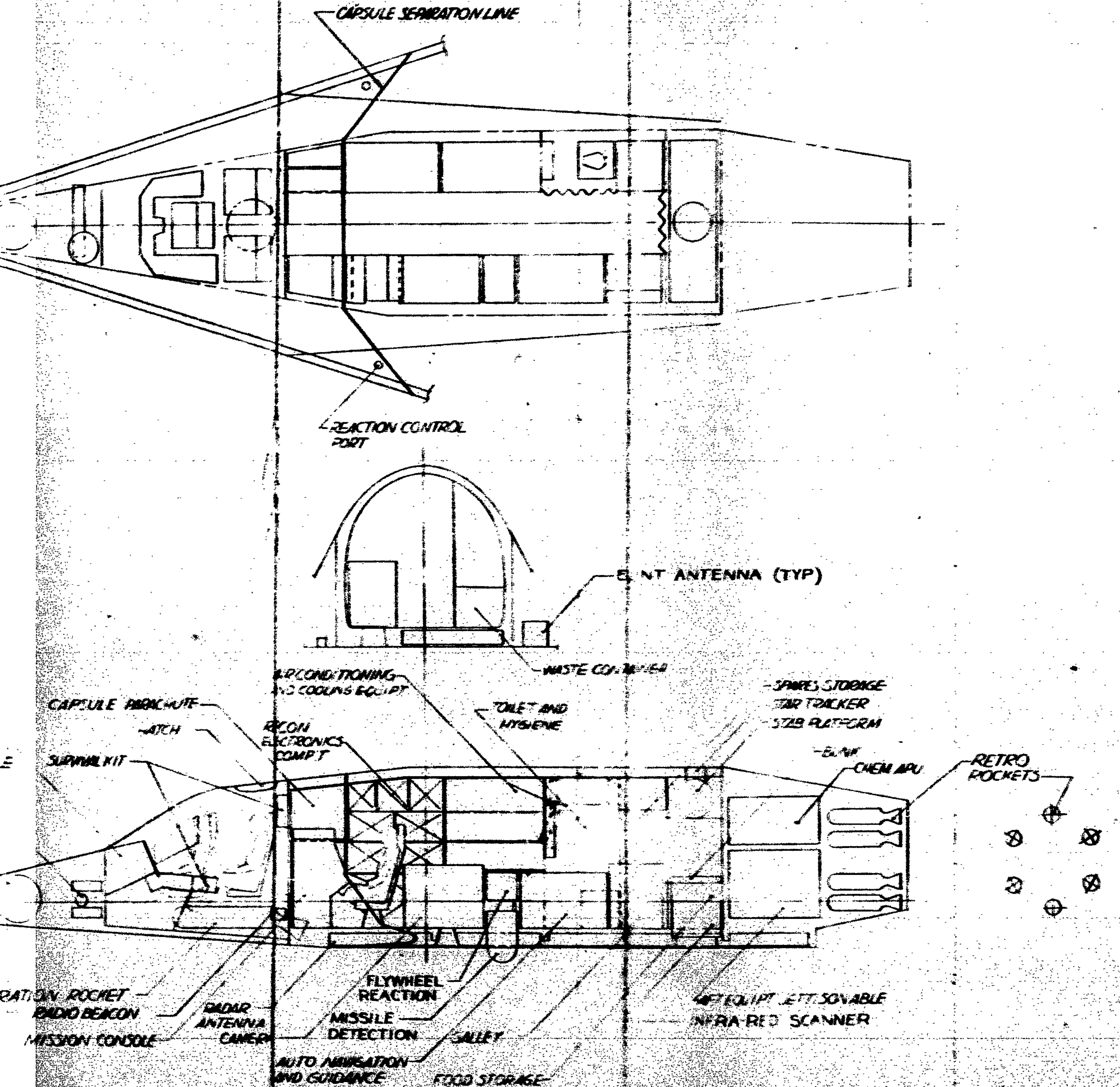

MANNED ORBITAL RECONNAISSANCE VEHICLE
814-3009

FIGURE IV A 4

SECRET

INBOARD PROFILE
MODEL
814-3009

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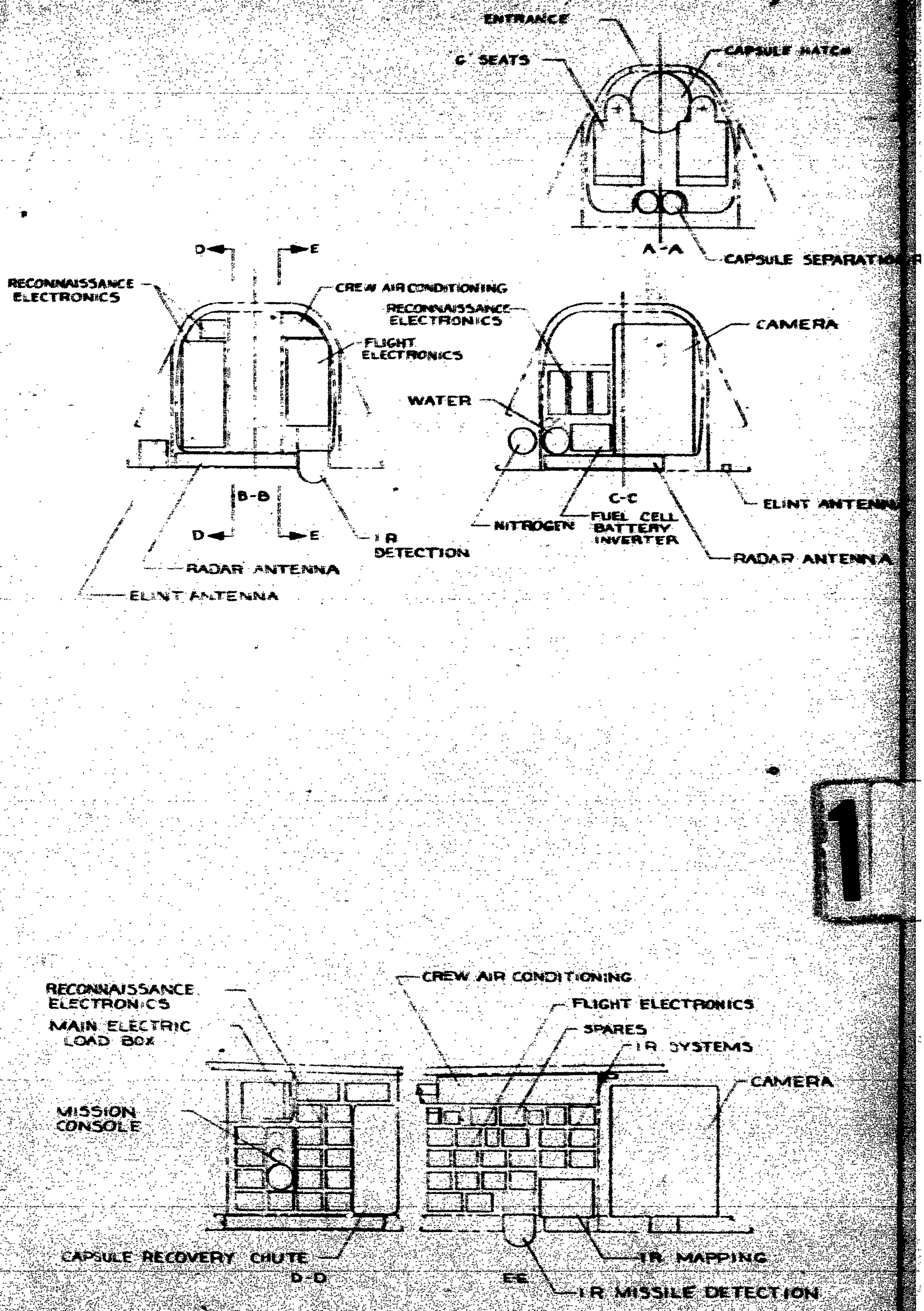
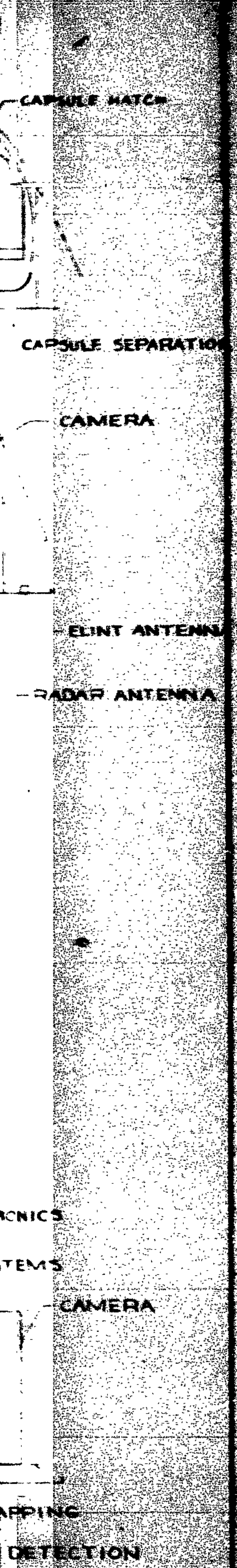
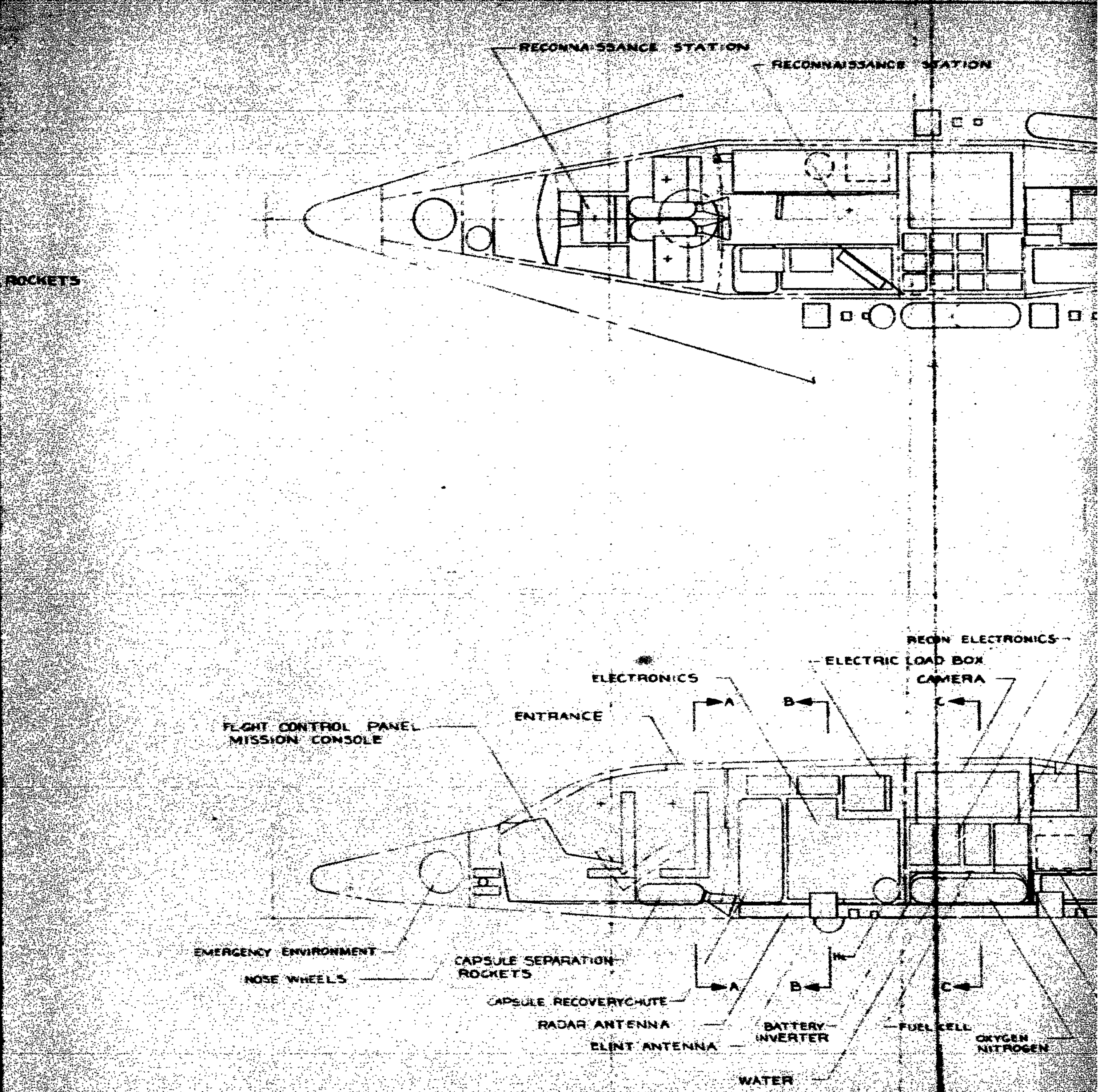
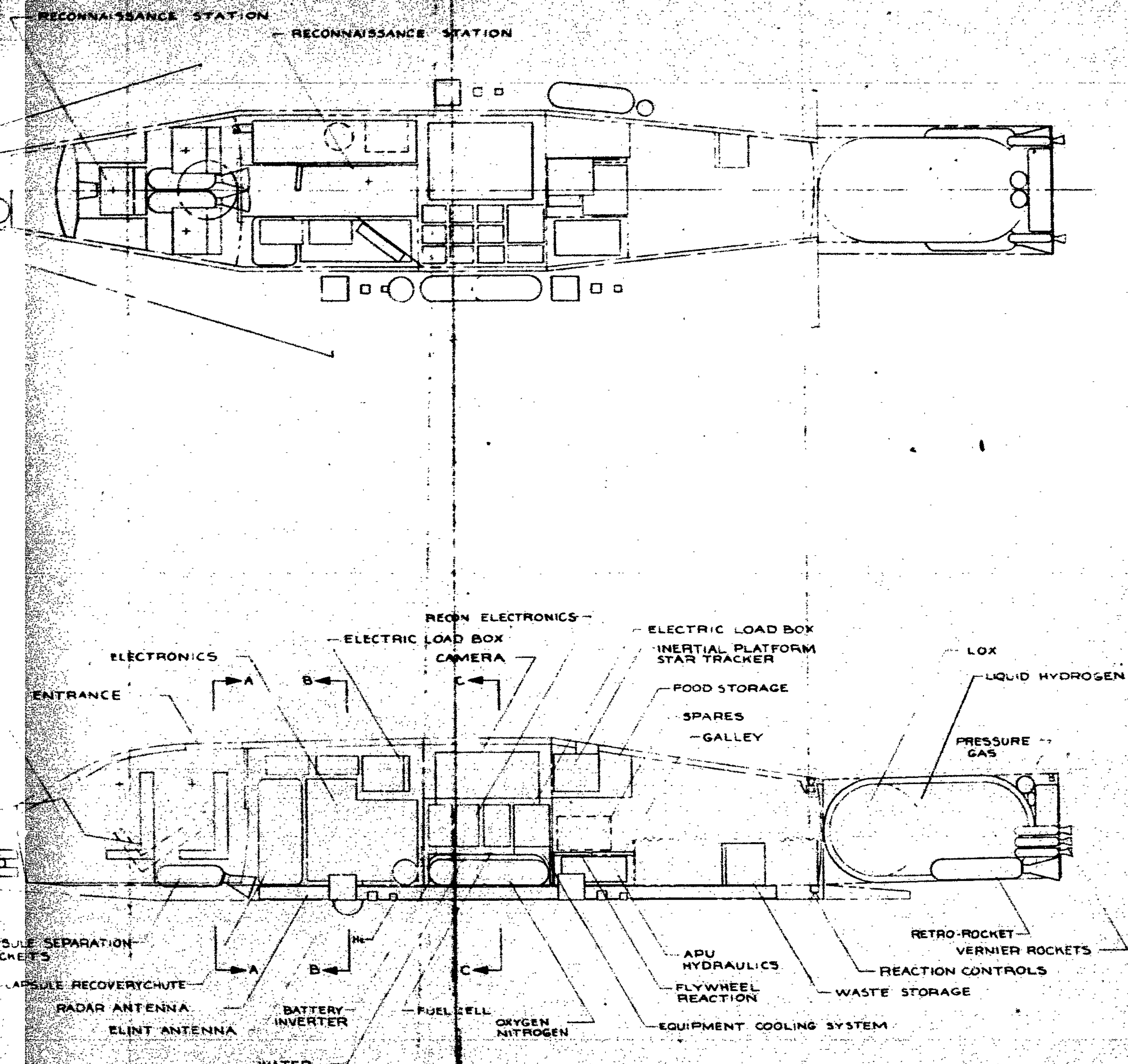


ENTRANCE
C SEATS
CAPSULE HATCH
A-A
CAPSULE SEPARATION
RECONNAISSANCE ELECTRONICS
CREW AIR CONDITIONING
FLIGHT ELECTRONICS
B-B
I R DETECTION
RADAR ANTENNA
ELINT ANTENNA
RECONNAISSANCE ELECTRONICS
CAMERA
WATER
C-C
NITROGEN
FUEL CELL BATTERY INVERTER
ELINT ANTENNA
RADAR ANTENNA
RECONNAISSANCE ELECTRONICS
MAIN ELECTRIC LOAD BOX
MISSION CONSOLE
CAPSULE RECOVERY CHUTE
D-D
CREW AIR CONDITIONING
FLIGHT ELECTRONICS
SPARES
I R SYSTEMS
CAMERA
I R MAPPING
E-E
I R MISSILE DETECTION





MANNED ORBITAL RECONNAISSANCE V
MODEL 814-301
1/20 SIZE



MANNED ORBITAL RECONNAISSANCE VEHICLE
MODEL 814-3011
1/20 SIZE

SECRET

MODEL 814-3011
MANNED ORBIT RECON
75-7790

tion equipment resolution capabilities. The band of hard radiation is well above this altitude and exposure of the crew to the weak radiation environment at 150 miles for a 14 day period should not be harmful.

Vernier rockets provide a capability of correcting v velocity error to achieve a circular orbit and control of vehicle spacing. Low wing loading and optimum c.g. location for re-entry and for landing are attained by placing heavy equipment well forward and expendables well aft. In case of need for re-entry before the expendables are used, provision is made to jettison the complete equipment bay in which they are installed.

Military Subsystems

All military subsystems are concerned with reconnaissance and are:

(1) IR Detection

(2) Elint

(3) Mapping IR, Radar, Photo

External Arrangement

The wing sweep, [illegible], fin and control surface arrangements are identical to those of DS-I. Compared to DS-I, the platform delta has been extended about seven feet and the fuselage has been widened to meet the space needs of the crew members. The vehicle is stabilized with the reconnaissance sensors always directed downwards towards

the earth. A particle shield is mounted in the aft end of the vehicle as shown in Figure IV.A-3. This shield is designed to stop small man-made particles which are put into orbit in the manner described in Section II of this document. A particle makes inelastic impact with the particle shield converting some of its kinetic energy into heat and compression energy. The particle then explodes, dissipating its momentum over a wide area. The shield utilizes solar cells to furnish the mass required to vaporize the particles. The solar cells are supported on a mylar bag stiffened by mylar tubes filled with foam. The bag is stored in the interstage structure between the vehicle and the fourth stage during launch. The vehicle rides tail-first in orbit..

Internal Arrangement

The crew is placed forward in the Flight Capsule nose section for boost and landing and also during escape. The main crew compartment is separated from the capsule compartment by means of a pressure bulkhead with door normally positioned loosely in the closed position to expedite emergency procedure. One of the work stations is in the forward position of the vehicle. The electronic equipment which supplies the detection sensors is mounted well forward, just aft of the capsule pressure bulkhead and adjacent to the second crew work station. Placement and mounting is such that essential maintenance and checking can be performed.

Expendables such as APU fuels, and hazardous materials are installed aft of the crew compartment pressure bulkhead in a separate compartment. This compartment, which includes the empty retro-rocket cases, is jettisoned upon re-entry.

The vehicle primary structure follows the DS-I determinate truss concept with skins transmitting normal pressures to the trusses. The crew areas are pressure containers of sandwich construction both skins of which are pressure tight for dual reliability.

Crew Accommodations

The pilot's flight panel is also used as an orbital working station. By means of a mode selector, the horizontal situation display screen is useable for the IR detect or ELINT tasks.

A second work station is provided aft of the capsule pressure bulkhead for use of the mapping operator.

Crew members rotate such that one member is off duty while the other two are on.

A rest station, exercise area, toilet and sanitary facilities, and a galley are provided within the crew compartment. The toilet and rest area are partitioned for privacy.

Control of the internal environment for a re-entry exactly follows the DS-I concept. A closed system refrigeration cycle is needed to handle the equipment heat loads for

the orbital flight phase.

Makeup oxygen and nitrogen from liquid sources replenish the breathing supply used by the men and lost by leakage. The oxygen partial pressure is sea level equivalent, whereas the total internal pressure is maintained equivalent to an altitude of 15,000 feet. The air is processed to remove carbon dioxide, odors and water vapor. The reprocessing intake is placed within the toilet compartment.

The nose section capsule is used for escape and will perform in the same manner as the DS-I capsule.

Power Source

The particle shield doubles as a solar power collector. But since its capacity and efficiency are both low, supplementary power is provided by means of "fuel cells" which produce electrical energy in combining oxygen and hydrogen to form water. This water by-product is used for cooling during the re-entry phase.

PRELIMINARY WEIGHT SUMMARY: GLIDER WITH PARTICLE SHIELD

Item	Weight - Pounds	
Wing	1250	
Body	2400	
Fins	590	
Control Surfaces	750	
TOTAL STRUCTURE		4990
Orbit Injection & Retro Rockets	520	
Capsule Separation Rockets	300	
TOTAL PROPULSION		820

Item	Weight - Pounds	
Auxiliary Power System-Inert	2460	
-Fuel	1360	
Reaction Control System-Inert	210	
-Fuel	100	
Hydraulic System	200	
Electric System	410	
SECONDARY POWER SYSTEM		4740
Capsule Environmental Control-Inert	500	
-Expendable	110	
Glider Environmental Control-Inert	530	
-Expendable	240	
TOTAL ENVIRONMENTAL CONTROL		1380
TOTAL ELECTRONICS		3710
FLIGHT CONTROLS		340
LANDING GEAR		540
CREW OPERATIONS (Incl. Crewmen)		2160
TOTAL GLIDER		18,980

(2) Orbital Reconnaissance Vehicle Interstage Accessory Power Unit

Vehicle configuration and inboard arrangement are shown in Figures IV.A-3a and IV.A-4a. Vehicle is similar in construction to that described in paragraph (1) above. It has the same leading edge sweep and similar [illegible] throughout. The combination particle shield and [illegible] connector utilized on the other configuration have been eliminated. Large liquid hydrogen and lox tanks have been provided in the interstage between the booster and the vehicle to provide an adequate source of fuel for the vehicle's APU's.

The internal configuration is designed to take advantage of the unusual environment which is associated with weightless conditions encountered in orbital flight. The need for conventional passage ways is eliminated by this condition. Therefore, it is possible to locate equipment in a more compact arrangement by providing only tunnels for access. It is possible for the crew man to propel himself thru the tunnels by a system of rails and straps. The configuration chosen for this concept provides maximum utilization of internal space by installing equipment on the "floor" and "ceiling".

Military and other vehicle subsystems and equipment are basically those of the configuration described in paragraph (1). Crew accommodations and work stations are based on the same requirements, although there is some difference in individual arrangements.

Power Source

Vehicle power requirements are supplied by two hydrogen-oxygen engines plus a hydrogen-oxygen fuel cell. During orbit one engine can supply the short duration radar peak loads thus permitting the other engine to act as a standby unit. Fuel for these engines is stored in the interstage which is attached to the basic glider. Duty cycles are shown in the load analysis, Figures IV.A-11 and IV.A-12. These units have the capability to supply the large hydraulic and other re-entry loads.

Preliminary Weight Statement: Glider with Interstage Accessory Power Fuel

Item	Weight - Pounds	
Wing	1250	
Body	2400	
Fins	590	
Control Surfaces	750	
TOTAL STRUCTURE		4990
Orbit Injection & Retro Rockets	520	
Capsule Separation Rockets	300	
TOTAL PROPULSION		820
Auxiliary Power System - Inert	530	
- Fuel	90	
Reaction Control System - Inert	210	
- Fuel	100	
Hydraulic System	200	
Electric System	410	
SECONDARY POWER SYSTEM		1540
Capsule Environmental Control - Inert	500	
- Expendable	100	
Glider Environmental Control - Inert	540	
- Expendable	240	
TOTAL ENVIRONMENTAL CONTROL		1380
TOTAL ELECTRONICS		3710
FLIGHT CONTROLS		340
LANDING GEAR		540
CREW OPERATIONS (incl. Crewmen)		2160
TOTAL GLIDER		15,480
FUEL, TANK & INTERSTAGE STRUCTURE		750
APU FUEL		1830
APU FUEL SYSTEM		50
TOTAL "PAYLOAD"		18,110

Booster System

The booster for this reconnaissance vehicle is a two-stage booster. (See Figure IV.A.5) The first stage is recoverable. It uses liquid oxygen and liquid hydrocarbon propellants. The second stage goes into orbit with the glider and is expendable. It uses liquid oxygen and liquid hydrogen propellants. (See Section V. for more information on boosters).

The first stage attains a burnout velocity of 6,000 fps. The upper stage has been sized to place an 18,680 pound glider in a 150 n.mi. altitude, circular, polar orbit.

Weight Statement

	Weight - Pounds
Glider	18,680
Second Stage	
Burnout	32,800
Propellant	127,500
Start Burning	160,300
First Stage	
Weight Empty	61,900
Pilot	250
Trapped Rocket Prop.	4,300
Turbojet Fuel	16,000
Propellant	432,000
Launch Weight	694,750

%2c

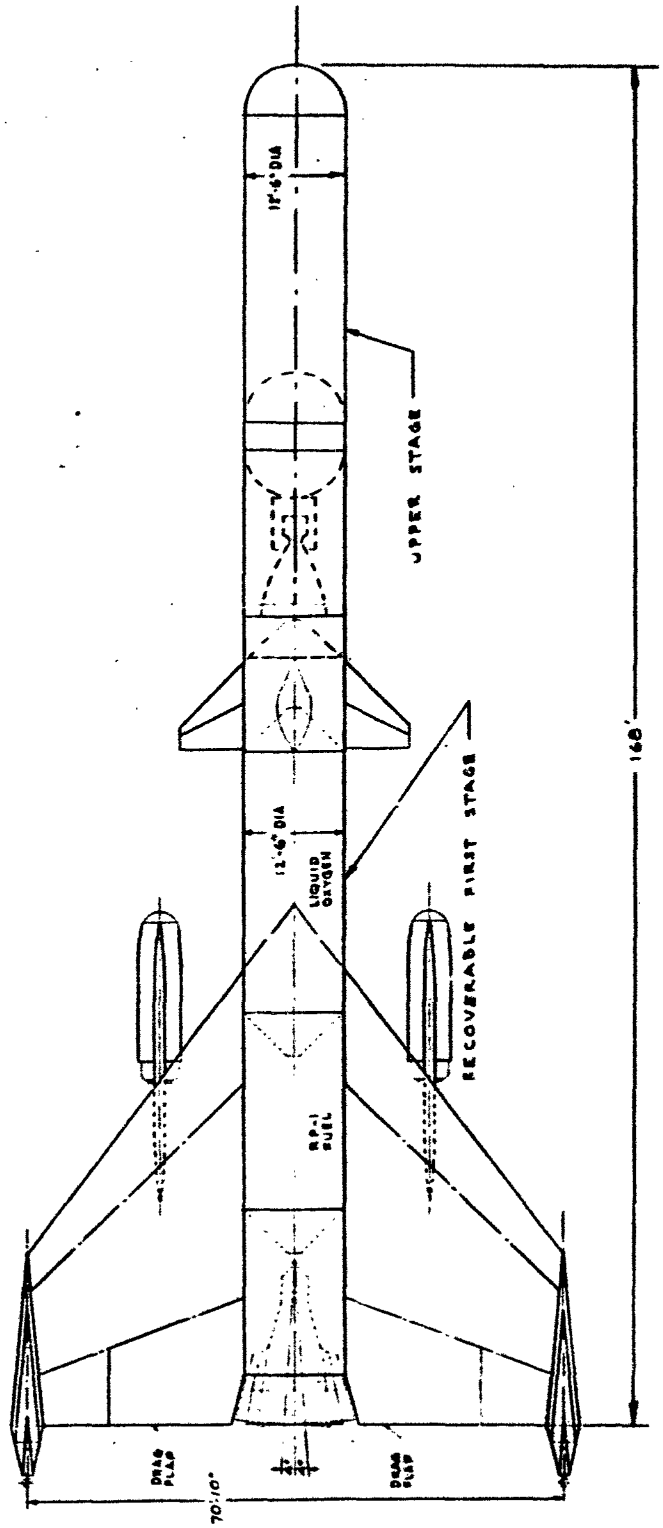
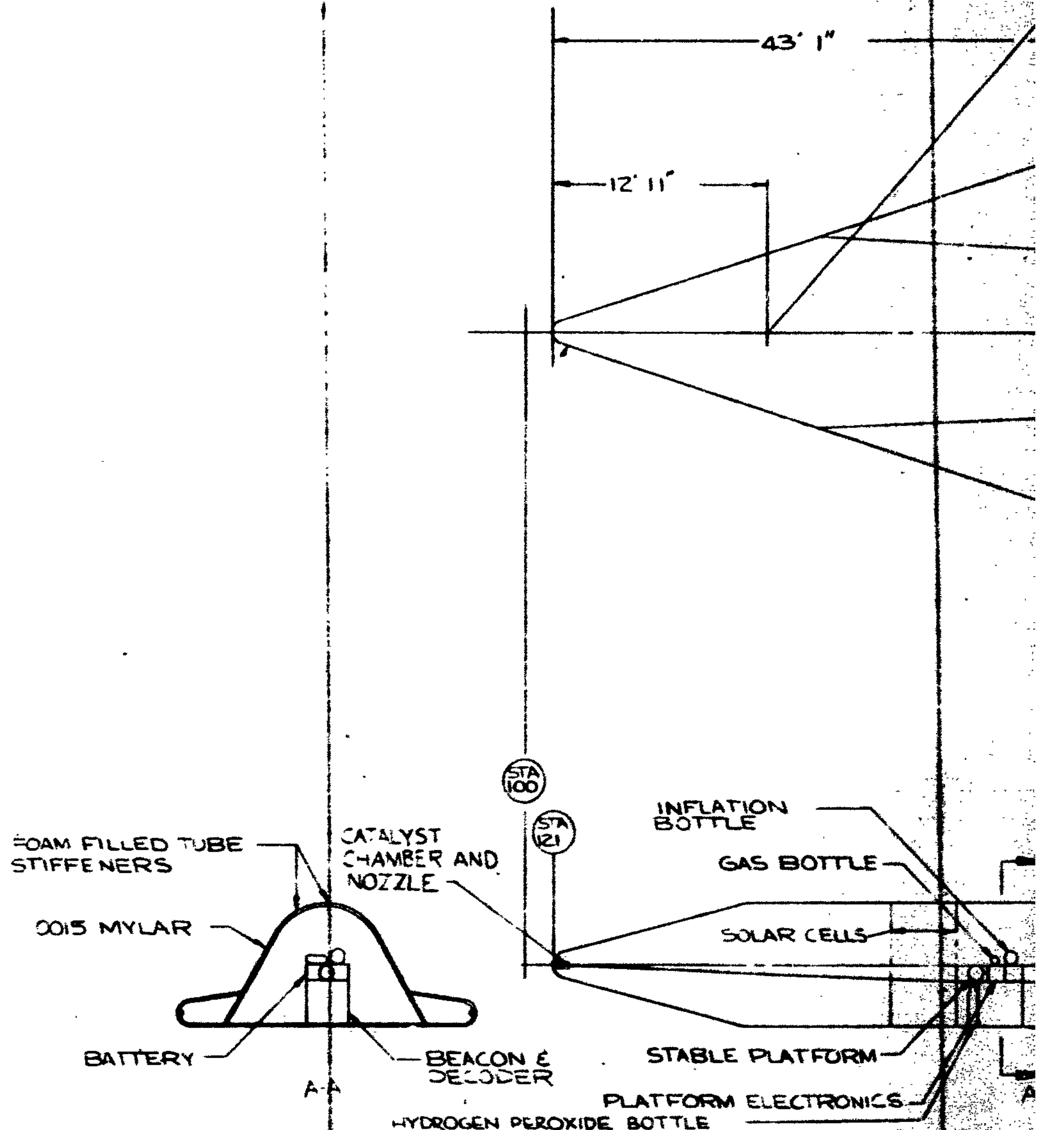

18'-6" DIA
UPPER STAGE
12'-6" DIA
LIQUID OXYGEN
RECOVERABLE FIRST STAGE
RP-1 FUEL
168'
DRAG FLAP
DRAG FLAP
70'-10"

FIGURE IV.A.5

Decoys

Ten orbital decoys per reconnaissance vehicle are launched individually into the same orbit with random spacing between them. (See Figure IV.A-6.)

The decoy is an inflatable balloon-type, the same size and shape as the parent vehicle, stiffened by foam-filled plastic tubes. The decoy has an attached simulated particle shield. It is stabilized in three axes to prevent tumbling in order to forestall discrimination by radar or optical means. The stabilization reference is a three axis stable platform. Stabilization is effected by a combination flywheel and jet system. A cool jet propulsion system utilizing hydrogen peroxide decomposed in a catalyst chamber is used to compensate for the differences in the mass-to-drag ratio of the decoy and the parent vehicle. This propulsion system operates only over friendly territory. A beacon similar to the one in the parent is included to prevent discrimination by the absence of beacon returns. A clock is provided to time the beacon-on-period and the propulsion system operation time. Power is supplied through solar cells located on the wings of the decoy, and by batteries during the periods when the vehicle is in the shadow of the earth. The expected lifetime of the decoys is 14 days to match that of the parent vehicle. No destruction of the decoy is planned after its useful life is finished.



ORBITAL RECONNA
MODEL 814-

FIGURE 1

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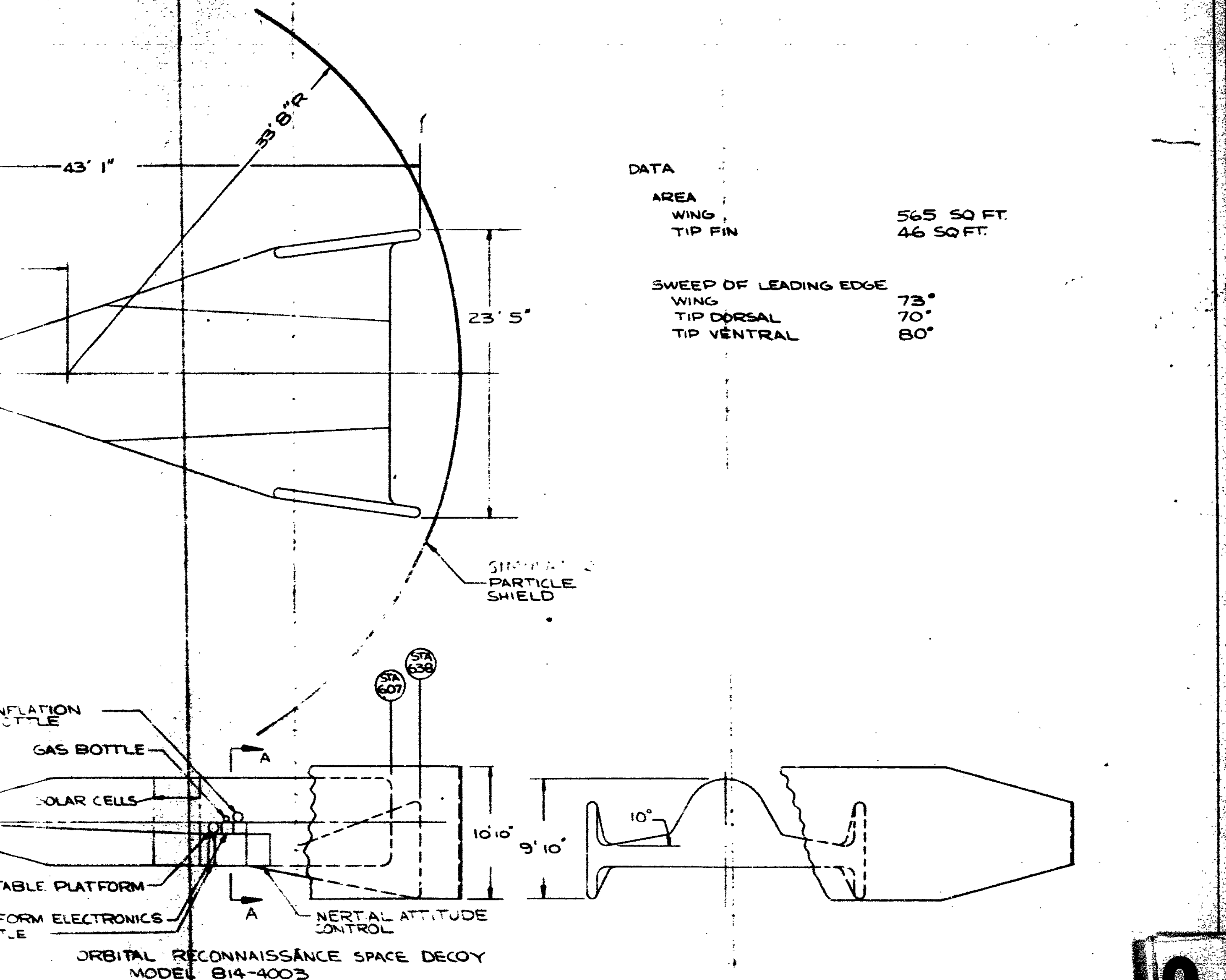

FIGURE IV A 6

GEN'L ARRANGEMENT
ORBITAL RECON DECOY
MODEL 814-4003
75-7765

b. Reconnaissance Subsystem (Configurations IV.A-3 & IV.A-3a)

A typical loading of reconnaissance sensors is shown in the block diagram, Figure IV.A-7.

The Early Warning - Infra Red Scanner Unit is designed to supply information on enemy firings of ballistic missiles, and thus enhance the early warning function already in the nation's arsenal.

The unit is a single-band, rapid-scanning system, searching 360° in azimuth, and detecting the radiation from missile boosters at ranges of 1500 N. miles. The wavelength bands chosen for detection are those which are absorbed by water vapor in the atmosphere below 30,000 feet. This means that missiles must break above this altitude before detection, but it also eliminates to a large degree the false alarms from hot ground sources. The sun and other bright stars are programmed out of this system by the inertial guidance equipment. An alarm system connected to the detection apparatus warns the operator that a bright object is in the field of view of the missile detection IR.

The display is arranged so that a trained operator can deduce enough angular trajectory information to verify that the object sighted is a missile. The operator then communicates reports on his sightings to the ground, where information is correlated from other orbital reconnaissance vehicles within range. The missile detection IR system occupies 6.5 ft^3, weighs 170#, uses 350 W. of power. It looks through a 14" diameter retractable hemispherical dome oriented toward the earth.

In-Flight Phase

Note: Provision is made for alternative recon loads.

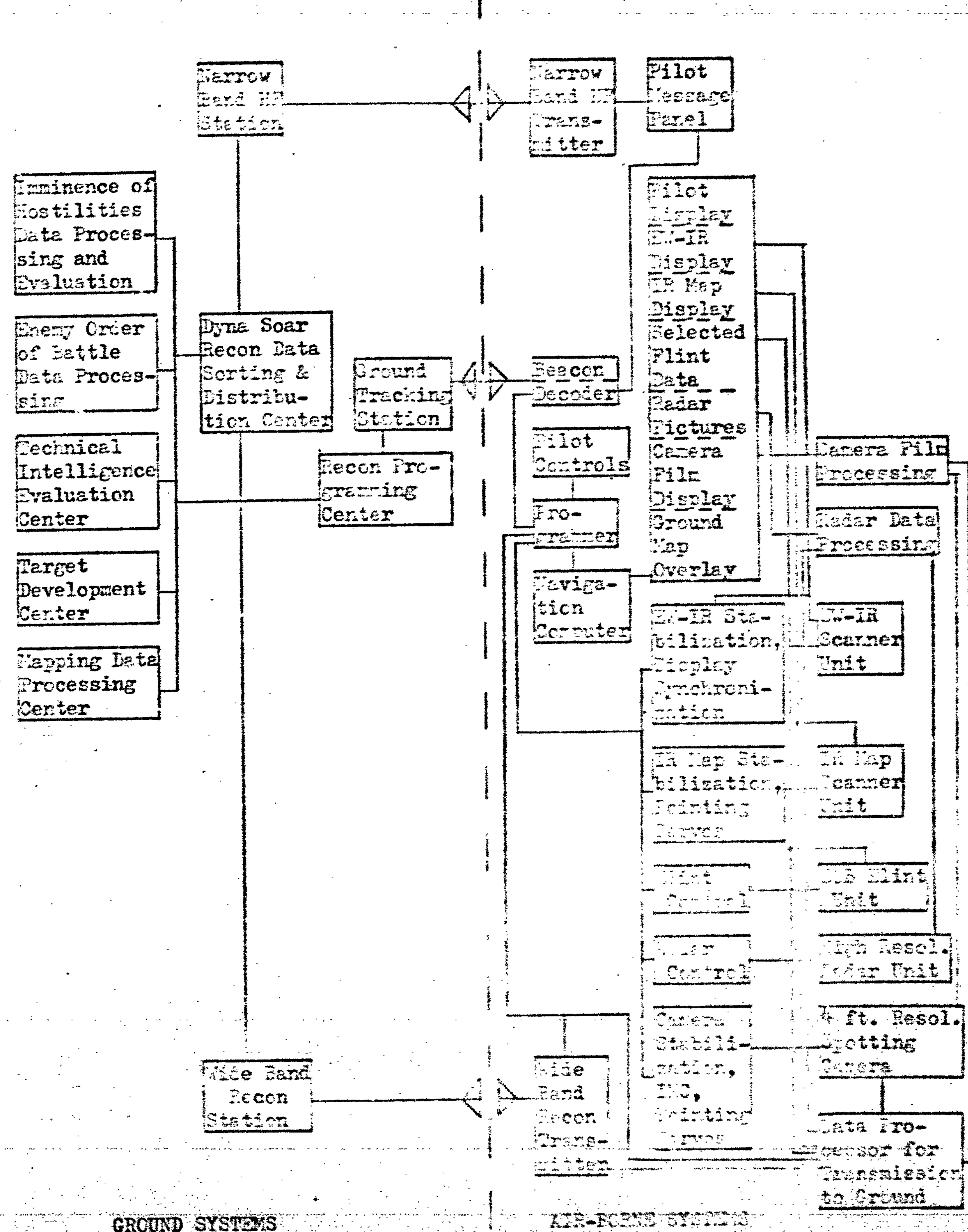

Figure IV.A-7. Reconnaissance Equipment, Orbital Reconnaissance Vehicle

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The High Resolution Radar has the same functions as in the Hypersonic Reconnaissance System, namely, all-weather surveillance, penetration of optical countermeasures, and provision of independent bits of data for a more complete description of objects of interest through cooperative sensor operation and an integrated display.

The radar is similar to the radar in the Hypersonic Reconnaissance System in that both use optical filtering of coherent radar returns for azimuthal resolution and the "PEEP" method of pulse compression for obtaining good range resolution with adequate signal-to-noise ratio. The radar for use in the orbital system must, however, have a higher average transmitter power, larger antenna and better angular resolution to give the same performance at the greater ranges associated with the 150 N. mile altitude.

The orbital radar will map a strip 20 N. miles wide which may be selected arbitrarily and controlled to any ground range between 80 and 195 N. miles by steering the beam in depression angle. Other design parameters proposed are as follows:

Resolution	Approx. 50' in each dimension
Transmitter Peak Power	21,200 watts
Transmitter Average Power	540 watts
Pulse Repetition Frequency	4550/sec.
Transmitted Pulse Length	10 microsec.
Pulse Collapse Ratio	100 to 1
Receiver Noise Figure	8 db.
Antenna Type	Electronically steerable array
Antenna Aperture	4.5' x 20'
Data Processing and Display Time	10 sec.
Position Accuracy	1000 feet

The estimated installation requirements for the orbital radar are:

Antenna	360 lbs.	0.5' x 4.5' x 20'	---
R-T Unit	165	3.3 cu. ft.	4.2 kw.
Processor	100	3.3	1.0
Coupler	60	0.7	.08
Display (two)	320	14.0	2.0
Addition to Nav. Computer	30	1.0	.5

The IR Map Scanner Unit carried in this vehicle is a multi-band scan system having an angular scanning range of ± 10°, within ± 45° of the vertical and a ground resolution in the 160 to 180 foot range, and a temperature differential detection of from 5° Kelvin to 50° K depending on wave length. It is probable that a multi-color oscilloscopic display will be provided for pilot monitoring of all the detection channels simultaneously. All intercepted data will be stored on either magnetic tape or film.

The IR Mapping System occupies 5 ft.^{3}, weighs 200 lbs. (including special cooling for the detectors to last two weeks) and uses 225 W.

The EOB Elint Unit is an electronic reconnaissance system capable of determining the electronic order of battle of those systems that are radiating. Such a unit will provide locational and radio analysis of signal sources radiating in the bands from VHF to X-band or above. Programmed in-flight analysis will determine direction of the sources, signal strength, pulse repetition frequency, pulse width, radio frequency, etc. The output of the analysis equipment will be stored on magnetic tape.

The programming system controls the analysis time, pilot display functions, information to be transmitted to the ground, and priority of signals and priority of areas. In addition, this unit selects signals of unusual or interesting characteristics and directs them to an oscilloscope display and photographic memory. Special "tip off" radiations linked with imminence of hostilities would be displayed to the crew.

The EOB Elint System (including antennas) occupies 7 $ft.^3$, weighs [illegible] lbs., and consumes 400 W.

It is possible as an alternate load to install the technical intelligence Elint reconnaissance system. This is capable of doing a much more detailed analysis of unusual signals. The crew assists the analysis by optimizing the machine adjustments for the most favorable display and recording.

The Technical Intelligence Elint System (including antennas) occupies 11.5 $ft.^3$, weighs [illegible] lbs., and consumes 750 W.

The High Resolution Spotting Camera:

The camera normally carried in the orbital reconnaissance vehicle is a technical intelligence-type camera. Internal programmers, with crew override capabilities, plan and execute the photography of definite areas of enemy territory. Pictures are then processed in the vehicle, and certain of the processed film is selected by the programmer for display to the crew. A basic library of photographs is carried for comparison with new pictures taken.

The program can be changed by ground control on every pass over the ZI. The observer functions principally as a data reduction machine. He may scan the photographs of selected areas, and investigate in them the probability of a build-up to imminent hostilities. He may utilize his narrow-band data-link to transfer his conclusions to intelligence centers in the U.S. In the event that one or two pictures may be of further immediate interest to ground intelligence centers, he may program his wide-band data-link to transmit these pictures to the ground. In the event that there is a large build-up of information which must be transferred to the ground, a pilot may land his vehicle.

Stereoscopic and passive night photo systems are being studied as augmentative additions to the basic system described above.

The extremely high resolution (4 ft.) obtained from the orbital altitude of 150 miles creates severe requirements for image motion compensation (IMC) and camera stabilization. These are discussed separately.

Image Motion Compensation:

Precise velocity information from the navigation computer (see Guidance and Control Section) is used for Image Motion Compensation. Radar-inertial altitude is also utilized.

Stabilization:

Past experience in stabilizing long, focal-length cameras indicates that proper stabilization techniques will not

significantly limit the camera resolution. Attitude signals from the navigation system will be used although more information is needed about them. It is expected that the high-resolution camera system will have to provide its own rate gyros. Vibration isolation will be provided for rotating machinery installed in the vehicle as well as for the camera itself.

The high resolution camera is valuable for spotting, targeting, and technical intelligence as well as an aid in determination of imminence of hostilities. Its physical description is: Weight - 850 lbs.; Volume - 33.7 ft.^{3}; Power consumed - 1800 W.

c. Guidance and Control.

The guidance and control system for the orbital reconnaissance vehicle is shown in Figure IV.A-8.

The system is very similar to that used for the Orbital Warhead System (see Chapter IV.B, where the various components are described).

An inertial guidance system is used during the launch phase. The inertial platform is aligned prior to take-off with the aid of a star-tracker mounted on the platform. (The star-tracker's primary function is to keep the platform aligned during the two weeks in orbit.)

Outputs from the navigation computer control first of all the recoverable booster vehicle, followed by the second and third stage Booster Stability System and finally the Glider Stability

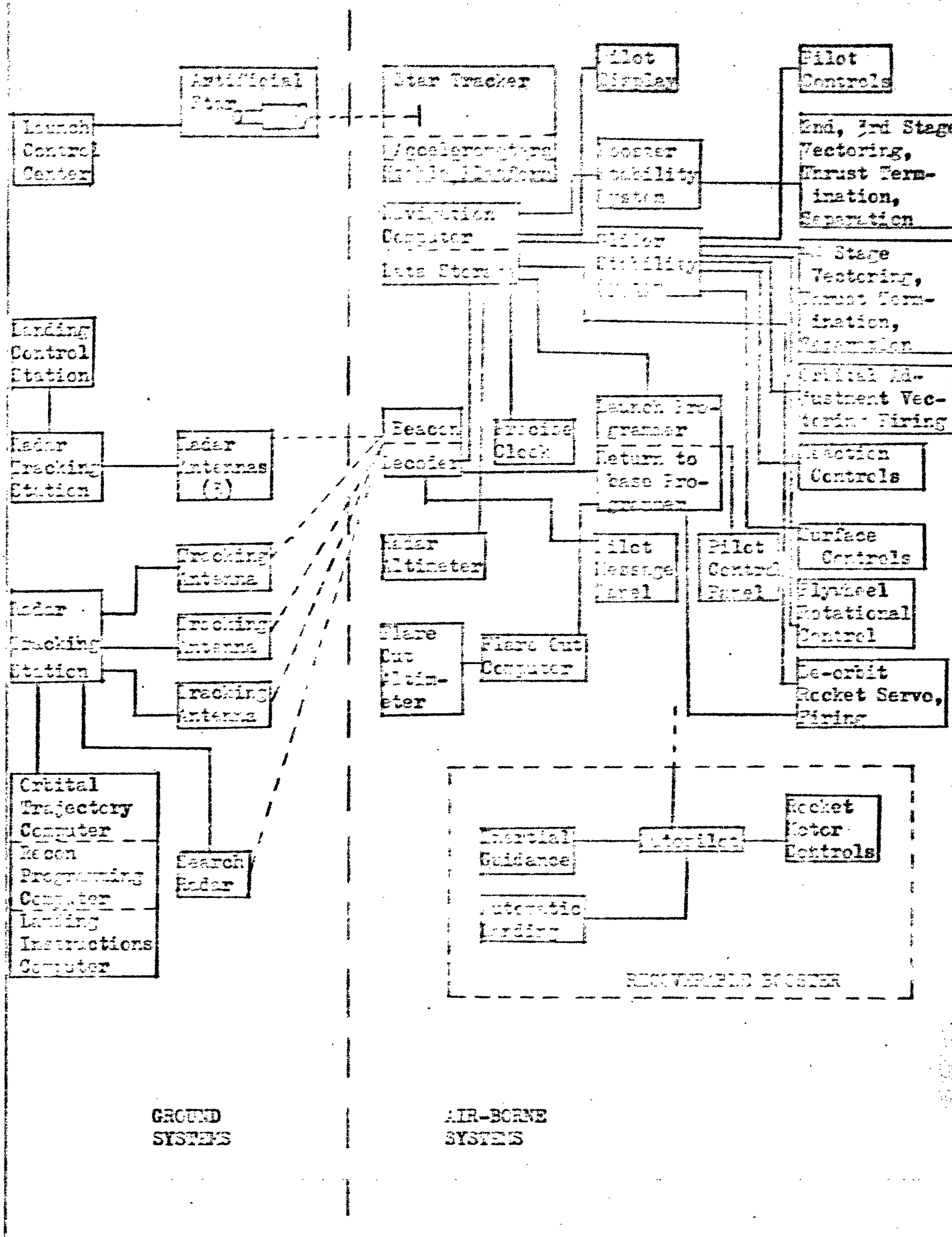


Figure IV.A-8. Guidance and Control, Orbital Reconnaissance Vehicle

System which operates during fourth stage vectoring, thrust termination and separation.

During the orbital flight phase the vehicle is tracked once per day by a precision radar tracking system located in the United States. A beacon in the vehicle, turned on by a clock as it passes over the station, responds with a coded address to the radar interrogation. The orbital trajectory is computed on the ground using the tracking data. When the vehicle has completed two passes around the earth an orbital correction is computed and relayed to the vehicle through the radar tracking link. The signal is decoded and used to control the firing of the Orbital Adjustment rocket.

The ground trajectory computer then re-computes the orbit trajectory daily and sends orbital parameter data to the vehicle daily through the radar-beacon link. Using this data and a precise clock, the vehicle navigation computer can then determine its position to an accuracy of two miles. Data obtained from the reconnaissance sensors can be used for later refinement of vehicle position.

Stabilization of the vehicle during flight is accomplished through Reaction Jets and a vernier Flywheel Reaction Control.

A separate search radar is used to acquire the vehicle the first time around after launch. When the orbit has been established, the Orbital Trajectory Computer will set the tracking radar on target.

Instructions for Return-to-Base are computed on the ground and relayed to the vehicle through the radar-beacon link. The Return-to-Base Programmer in the vehicle uses this data, with the navigation computer, to orient and fire the De-Orbit Rocket and to control the descent through the atmosphere.

A long range radar search and track station at the landing site acquires the vehicle and gives it correction commands. This radar is almost identical, except for positioning of the three tracking antennas, with the orbital tracking radar. The same beacon is used in the vehicle.

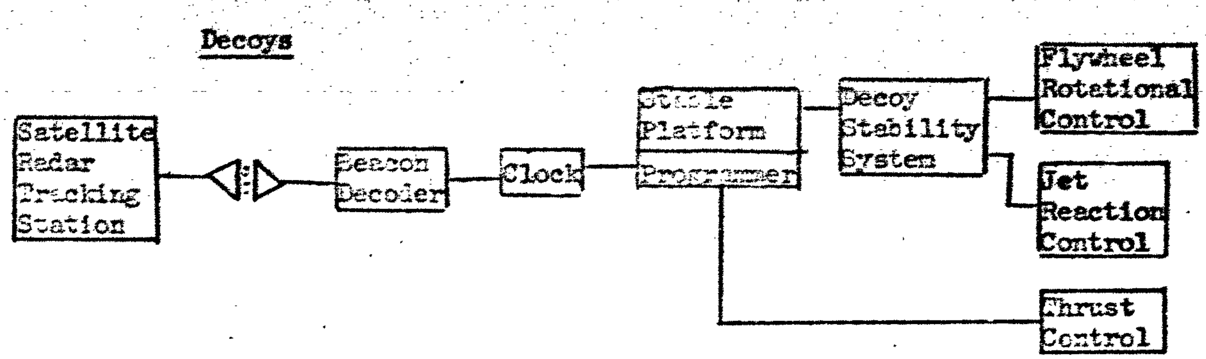
Flare-out is accomplished automatically.

The pilot can take over control of the vehicle during any phase of the operation, using the displays of navigation data and the pilot controls.

Orbital decoys are launched individually from the ground. Their guidance and control mechanisms are shown in Figure IV.A-9..

A gyroscope platform is used for stabilization of the decoy for its two week life. 0.05 deg./hour drift rates will be acceptable for this application.

The decoy is tracked from the ground to prevent discrimination on this basis. The decoy beacon is used to re-set a clock which controls attitude programming, thrust programming and turns the beacon on and off as it passes over the radar tracking station.



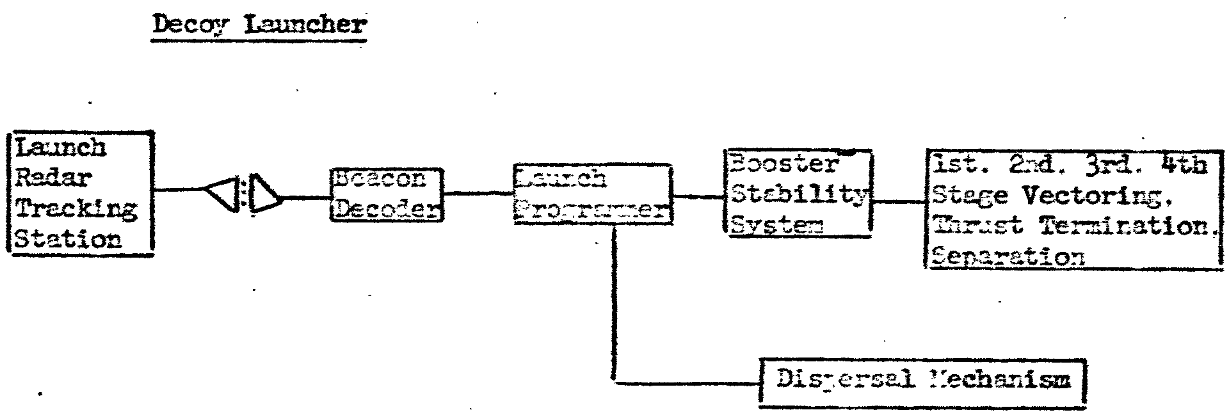


Figure IV A-9. Guidance and Control: Orbital Reconnaissance Decoys

Radar guidance is proposed for boost of the decoys into orbit (See Figure IV.A-9) using the same type of radar used for satellite tracking.

d. Miscellaneous Vehicle Sub-systems.

(1) Accessory Power Supply (See Figure IV.A-10) (Config. IV.A-3)

This vehicle, which operates on a two week mission, has a moderate base load, a high radar peak load, and a very high hydraulic load during re-entry as is shown in the load analysis, Figures IV.A-11 and IV.A-12. Solar or nuclear energy sources are the logical ones to use for such long flight times. Nuclear power was dropped because the weight advantage was not sufficient to offset the problems associated with radiation. Longer flight times would favor the use of nuclear power.

Solar power is not available during re-entry because a large solar collector cannot be maintained in an extended position. Hence, two hydrogen-oxygen engines were selected for supplying the large hydraulic and other re-entry loads. One of the engines can supply the short-duration radar peak loads without requiring a significant amount of additional fuel.

The pellet shield is covered with solar cells that supply part of the vehicle base electrical load requirement. (Figure IV.A-13). These solar cells also provide the mass required for the shield.

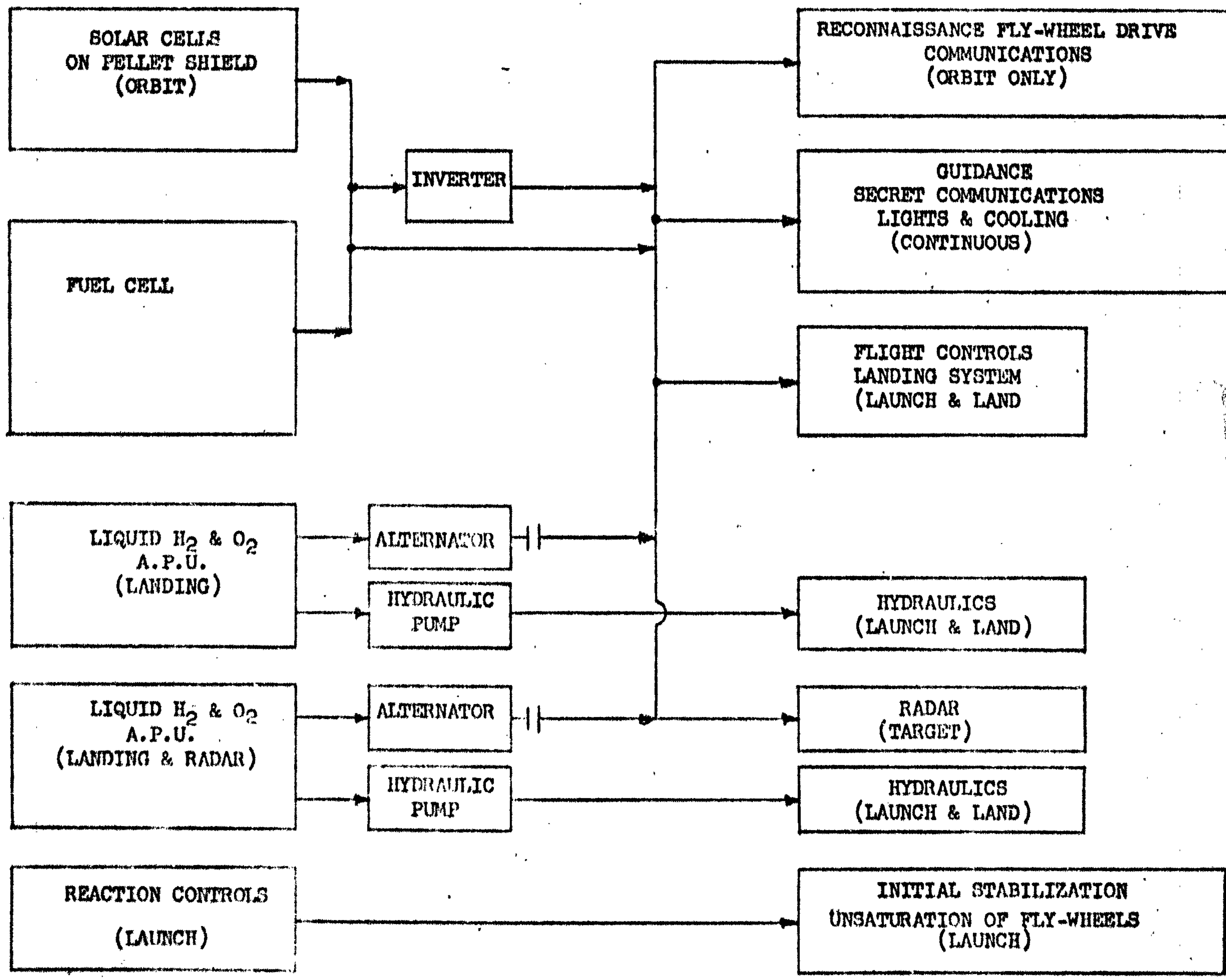


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FIG. IVA-10. SECONDARY POWER SUPPLY SYSTEM DIAGRAM CONFIG. IV.A.-3

	LAUNCH 10 Min	ORBIT 14 Days	OVER TARGET 84 PASSES	OVER BASE 5 Min	LANDING 1 Hour
GUIDANCE & CONTROL					
Radio Guidance	65				
Platform	400	400	400	400	400
Computer	350	350	350	350	350
Flight Control Elect.	310				310
Landing System					270
Fly Wheel Drive		50	50	50	
RECONNAISSANCE					
Hi-Resol Radar*			*		
Missile Detection I.R.		350	350	350	
Elint E.O.B.			500		
Photo-spotting			1800W		
COMMUNICATIONS					
Airborne Beacon				50	50
UHF Transceiver					200
Wide Band Xmtr				450	
Narrow Band Xmtr			400		
LIGHTS & CREW Comforts	100	100	100	100	100
TOTAL ELEC. LOAD	1225	1250	3950 + Radar	1750	1680
BLOWERS (CREW) FREON COMPRESSOR	1600	350 1940	350 1940	350 1940	1600
TOTAL ELECTRICAL	2825W	3540W	6240W+Radar	4040W	3280W
HYDRAULICS			*		63H.P.

*Radar: 1 kwh/pass, 1500W standby, 8000 watt peak

Figure IV.A-11. Load Analysis

65 Min x 3.64 = 230 kw. Min.
20 Min x 6.34 = 128 kw. Min.
5 Min x 4.14 = 21 kw. Min.
90 Min x Ave. = 379 kw. Min.

4.2 kw = Ave. Requirement

14 Days x 24 Hrs. = 336 Hrs.
4.2 x 336 ——— = 1410 kw Hr.
= 1900 HP-Hr.

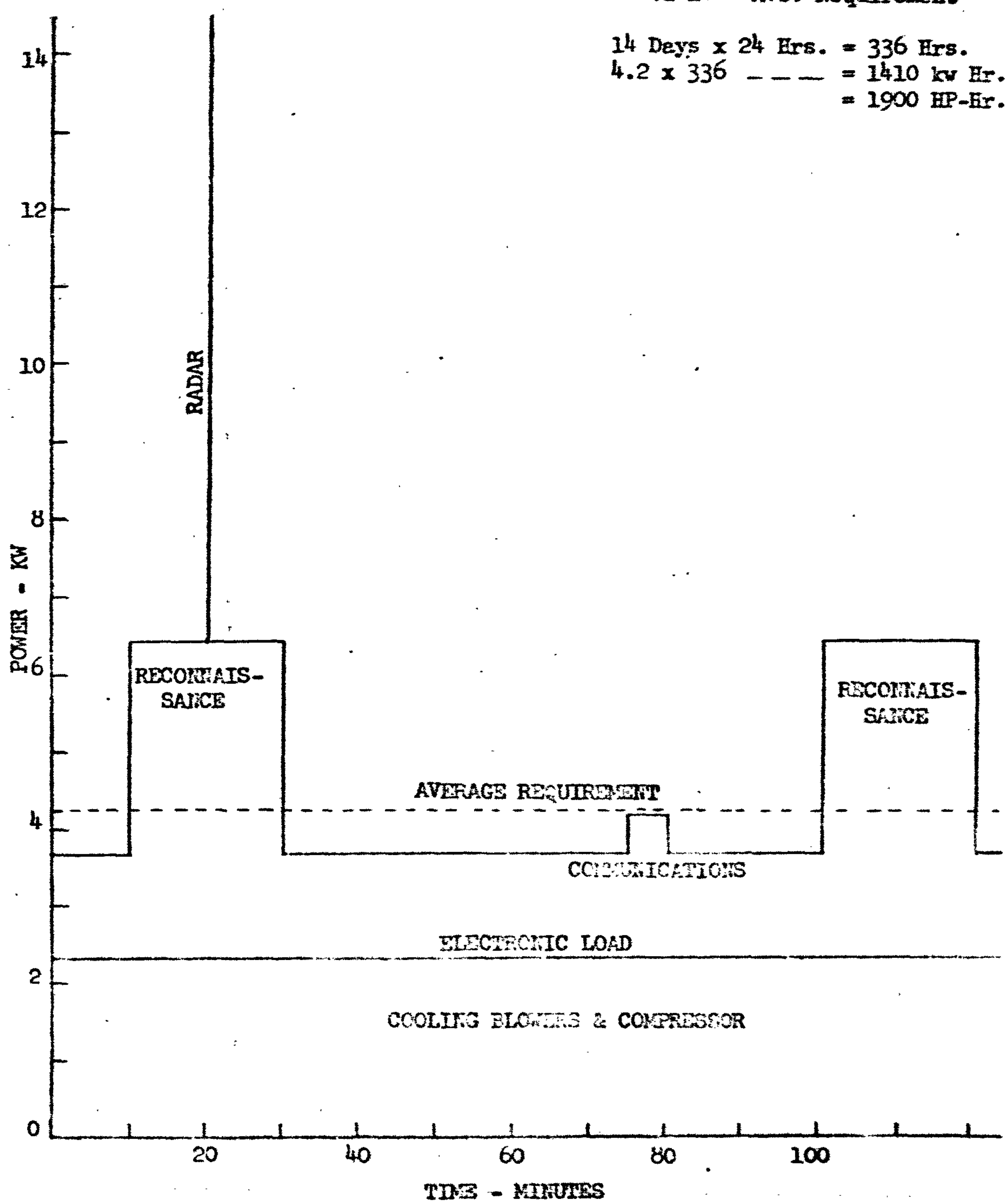
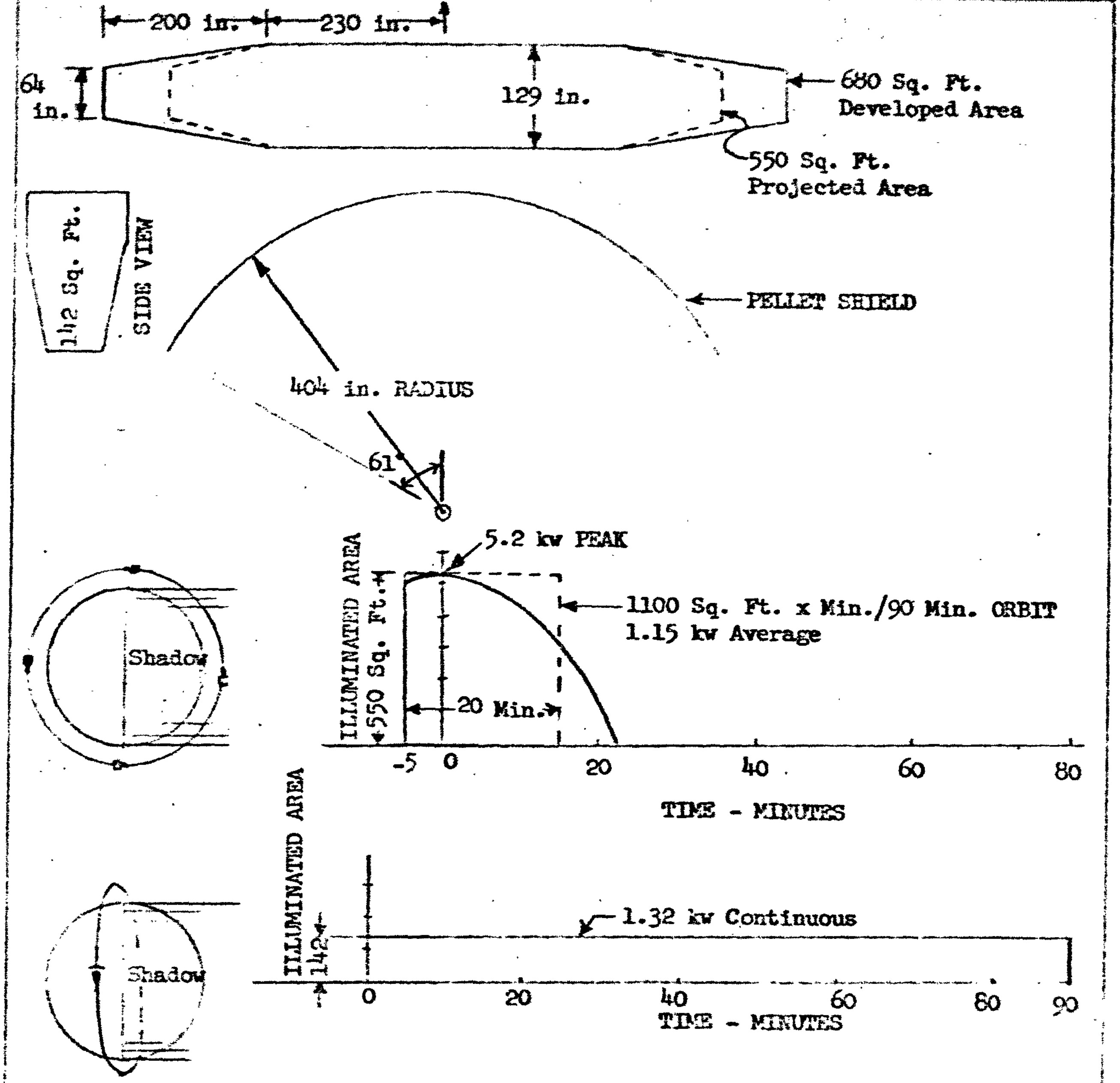


FIG. IVA-12. LOAD PROFILE



SOLAR POWER, AVERAGED OVER ALL TYPES OF POLAR ORBITS -- 1.25 kw

15 days x 24 hours in Orbit	360.0
3 x 1.5 Hr. Orbits without Solar Power	- 4.5
Solar Power Generation Time	355.5 Hours

Electric Load --	4.2 kw x 14 Days	1410 kw hr.
	2.1 kw x 1 Extra Day	+ 50 kw hr.
Electric Energy Required per Mission		1460 kw hr.
Energy produced by Solar System		-444 kw hr.
Energy required from Fuel Cells		1016 kw hr.

FIG. IVA-13. SOLAR POWER SUPPLY
C[illegible]IG. IV.A-3

The balance of the base load could have been supplied from an array of solar cells, but the installation would have been unwieldy and a large battery for nighttime energy would have been needed. It was found that high-efficiency fuel cells eliminated the need for the battery, and from an overall design standpoint, are the best source for the balance of base-load power. Thus, during the periods when the vehicle is in shadow or when the solar cells are poorly oriented with respect to the sun, power is supplied by the hydrogen-oxygen fuel cell (Figure IV.A-14). The fuels for the fuel cell as well as for the APU are stored as liquids in insulated tanks and are vaporized in a heat exchanger to absorb the waste heat rejected by the secondary power system. D-c electric power is taken directly from the fuel cells and solar cells and a-c power is furnished by an inverter.

Fuel from the fuel-cell tanks is also used in the hydrogen-oxygen engines that supply power during re-entry and landing. Each engine will drive an a-c generator. The two generators are automatically paralleled. If one engine or generator fails, the remaining generator furnishes enough electric power for the landing operation.

Each engine also drives a hydraulic pump which supplies hydraulic power to one of the two sides of each of the tandem flight-control actuators. Each of the pumps pressurizes a separate hydraulic system which alone is capable of supplying adequate power to the actuators.

HYDROGEN-OXYGEN FUEL CELL

$H_2 + \frac{1}{2} O_2 = H_2O + HEAT$
5670 BTU/Lb of H_2O
1.642 KWH/Lb
0.625 Lb/KWH at 100% Efficiency
50% Efficiency
1.25 Lb of Fuel/KW Hr

11% of Weight is H_2
89% of Weight is O_2

1016 KWH Requirement

1270 Lbs. of Fuel
140 Lbs. of H_2
1130 Lbs. of O_2

140/4.4 Lbs./Cu.Ft. H_2 = 32 Cu.Ft.
1130/71.0 Lbs./Cu.Ft. O_2 = 16 Cu.Ft.
48 Cu.Ft.

5 Lbs/Cu.Ft.	Tankage
240 Lbs	Tankage
100 Lbs	Dry Weight of Cells
340 Lbs.	Dry Weight
1270 Lbs.	Fuel
1610 Lbs.	System Weight for Fuel Cells

COMBINED POWER SUPPLY SYSTEM

(a) FOR ORBITAL CONDITION

Solar Collector & Pellet Shield	700 #
Extension, Wiring etc.	100 #
Fuel Cell - including Fuel	1610 #
Fuel-cell Controls	110 #
Inverter	80 #
COMBINED WEIGHT	2600 #
Less Weight Charged to Pellet Shield	-700 #
Total Orbital Power Supply	1900 #

(b) FOR LANDING CONDITION

2 Cryogenic APU's at 50#	100 #
Cryogenic Fuel (3 cu.ft.)	
For Re-entry and Landing	90 #
2 - 30-HP Hydraulic Pumps at 15# ea.	30 #
2 - 5 KVA Alternators at 20# ea.	40 #
COMBINED WEIGHT FOR ACCESSORY POWER	2160 #

FIG. IVA-14. FUEL CELL ANALYSIS

(2) Escape System

(a) Description

The vehicle is provided with a separable and controllable capsule utilizing the nose section of the basic vehicle. The plane of separation is immediately aft of the cockpit and is affected by a ballistic device or a shaped charge installation. Initiation is accomplished by the pilot, by remote ground control, or by an automatic system. Sufficient propulsion is provided to insure safe separation and trajectory throughout the various phases of the flight profile including the period on the launch pad.

Initiation of the escape procedure rests primarily with the pilot augmented, as necessary, by ground control or an airborne automatic system. Ground control will be able to initiate escape while the vehicle is on the launch pad and for some short period of time at the beginning of launch. In addition, ground control can terminate thrust during all of the first stage boost. The airborne automatic escape mode initiates the escape system in situations that are beyond the detection and response capabilities of the pilot or ground control.

If escape is initiated outside the sensible atmosphere, reaction controls and retardation thrust are used to maintain control of altitude and velocity for re-entry. The capsule is aerodynamically stable in the atmosphere.

A two-stage system, drag and descent parachutes, is used to decelerate and land the capsule. Deployment of the drag chute in the vicinity of 100,000 feet and the descent chutes at approximately 14,000 feet is automatically controlled. The descent rate at surface contact does not exceed 30 feet per second.

Hard surface impact shocks are reduced to non-injurious level by collapse of the capsule outer structure. The cockpit pressure shell (inner structure) is designed to preclude rupture in water landings and to provide capsule flotation until rescue. Upon surface contact automatic parachute release prevents tumbling and dragging.

The capsule provides shelter and protection for both land and water landings. Personal equipment for global survival is stowed in the capsule. Communication system, signals and markers are also provided to assist rescue operations.

For launch pad escape, the capsule flies a trajectory that provides altitude and displacement for a safe landing out of the hazard area. Chute deployment is automatic.

(b) Physiological Considerations

The escape operation will not impose physiological or psychological stresses on the pilot which exceed presently known tolerance limits. Acceleration forces

will not incapacitate the crew. The escape capsule environmental system maintains the pilot at physiologically safe conditions during escape and survival sequences. Temperatures will not exceed levels that would impair completion of escape and survival activities.

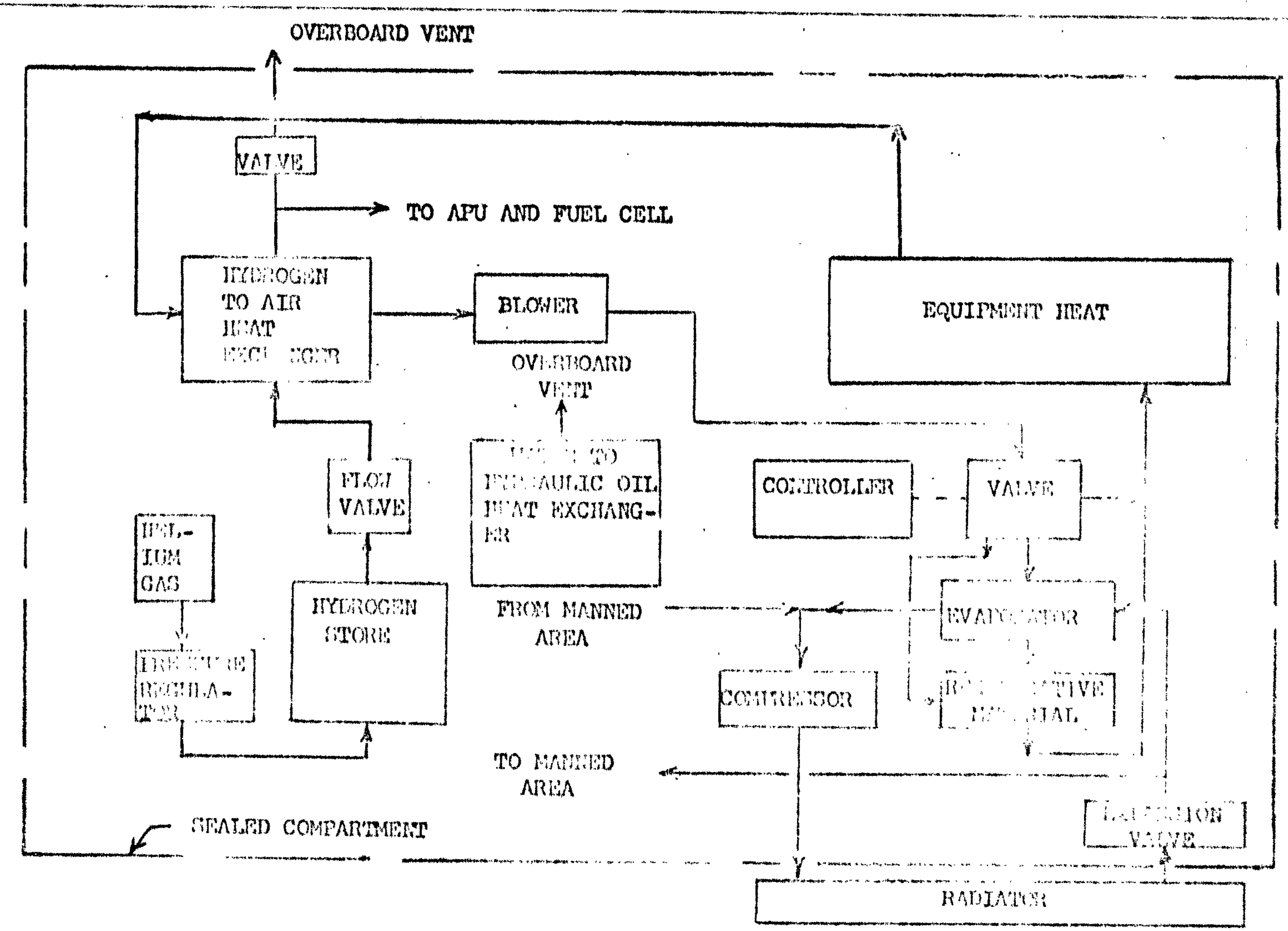
(3) Environmental Control

The vehicle contains one large pressure section which houses both crew and equipment in a nitrogen-oxygen atmosphere at a pressure altitude of 15,000 feet. The air used to cool the equipment is, however, confined and circulated in a system separate from the crew environment. See Figures IV.A-15 and IV.A-16.

In orbital flight, both crew and equipment systems utilize a Freon heat pump cycle to exhaust heat to space from a condenser-radiator. A regenerative material is used as a system ballast to smooth operations over the sunlight-darkness and heat surge cycles.

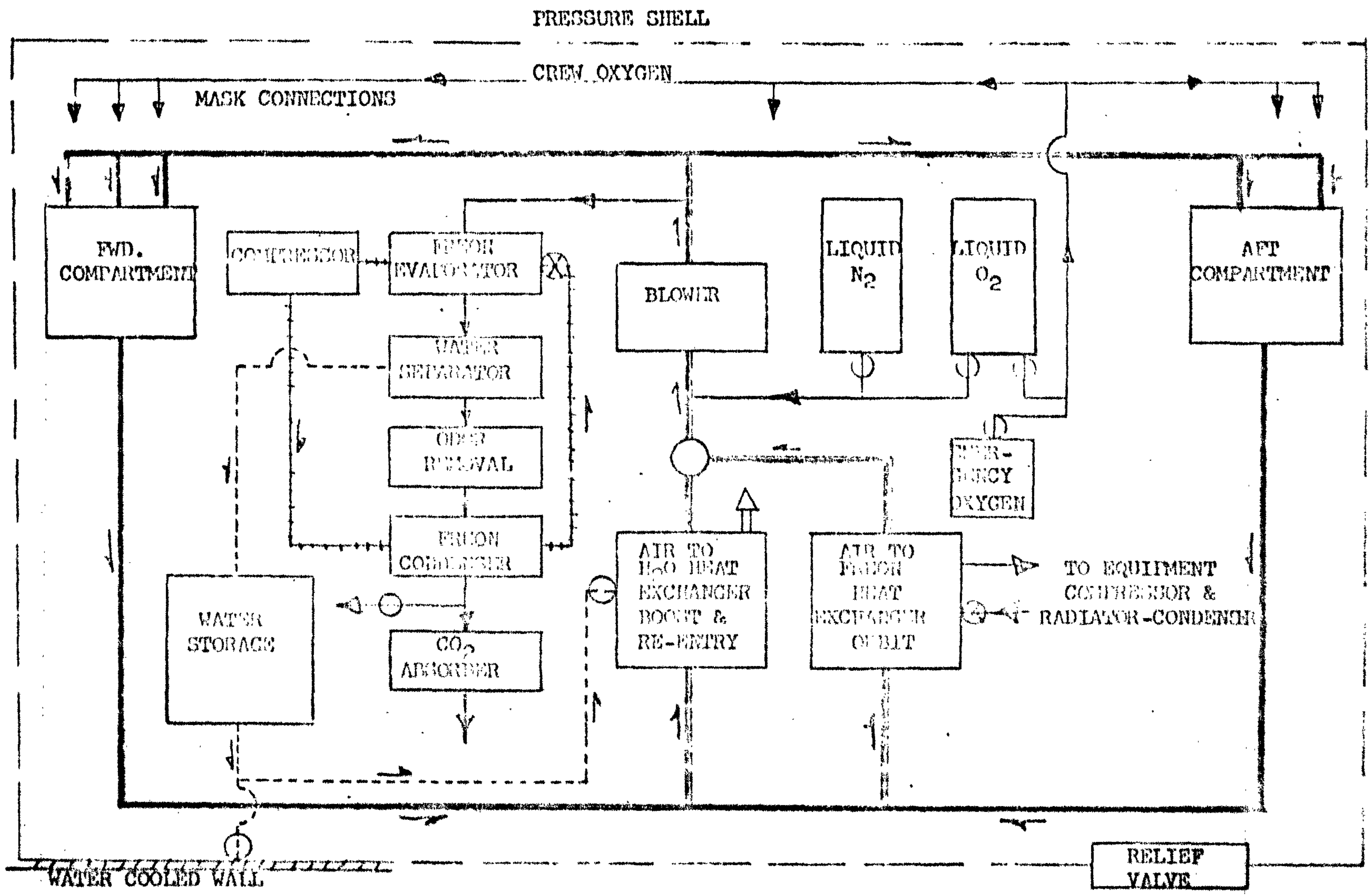
For boost and atmospheric re-entry, the crew system utilizes a water heat sink supplemented at low altitude by liquid air. The equipment system utilizes liquid hydrogen (furnished for fuel cells and APU) as the main heat sink. Hydraulic fluid is cooled by a self-contained water system. The pressure vessel is directly cooled by water evaporation during re-entry.

Leakage in the pressure vessel is held to 10 pounds per



EQUIPMENT COOLING AND PRESSURIZATION

FIGURE IV.A-15.



CREW ENVIRONMENTAL CONTROL

FIGURE IV.A-16.

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day. Oxygen consumption is 7 pounds per day. Atmospheric makeup is from separate liquid nitrogen and liquid oxygen tanks to maintain sea level oxygen partial pressure and 8.3 psia total pressure. Oxygen is also directly available to crew masks on demand.

Crew compartment temperature is controllable to 65°F plus or minus 10°F. Cooling air is supplied to the equipment at 80°F. Compartment relative humidity design value is 30%. Water vapor is condensed out using a small vapor cycle machine, mechanically separated and stored for use during re-entry. About 160 pounds of water are involved.

The carbon dioxide partial pressure is held below 8 mm of Hg, 1% of one atmosphere. The carbon dioxide is absorbed in molecular sieves from low relative humidity air. The molecular sieves are regenerated by exposing them to the ambient vacuum.

Other systems of heat dissipation, such as direct heat transport and radiation, are being explored. Various systems of CO_2 removal, water vapor removal and oxygen generation or supply are being investigated.

(4) Crew Accommodations

(a) Criteria

The crew provisions are arranged for protection and operating efficiency for the 14-day orbital mission. Environments are listed as follows with the requirements which they generate:

((1)) Force Environment

((a)) Restraint

A restraint system shall be provided to support the crew member and prevent his displacement during all phases of each mission. It shall prevent his impingement on cockpit protrusions and structure under the following conditions:

		Operating Conditions	Emergency Conditions
((1))	Accelerations along the spinal axis	1G 0G -1G	30G Crash 2G
((2))	Fore & Aft transverse accelerations	Fore 8G 0G Aft 1G	40G Crash
((3))	Side transverse acceleration	0G 4G	12G

((b)) Position

The position of the pilot permits him to be in effective control of the vehicle during the operating accelerations noted above. R

((c)) Equipment

Seat, harness and helmet are considered together as the complete restraint system. This equipment shall be capable of fast and easy doffing to enable the crew to quickly leave the vehicle upon landing.

((2)) The Pressure-Atmosphere Environment

((a)) Pressure

Internal pressure values are: sea level oxygen partial pressure; total pressure equivalent to 15,000 ft. altitude. Duality of pressure containment shall be provided. The pressure source, its valving and controllers shall be of reliable, fail-safe design.

((b)) Atmosphere Composition

Composition requirements are as follows:

(1) Oxygen content: 41%

(2) Nitrogen content: 58%

(3) CO_2 concentration: Max. 1%

(4) Maximum relative humidity: 30%

(5) Ventilation rate: 30-50 ft./min.

Primary and emergency sources of oxygen shall be provided. Oxygen and carbon dioxide status shall

be displayed to the pilot. The percentage of oxygen shall be automatically controlled, but a manual means for adjustment also shall be provided.

(3) The Acoustic and Vibration Environment

(a) Noise

The external booster and aerodynamic noise shall be attenuated such that the pilot experiences no more than 120 db on the body, 90 db at the ears. These intensity levels apply to all frequencies.

(b) Vibration

Low-frequency vibrations in the neighborhood of seven cycles per second cause resonant response in the abdominal cavity which can be of a dangerous nature. Support shall be supplied the abdominal region such that this resonance is damped out.

(4) The Temperature Environment

The pilot's clothing, gloves, shoes, helmet shall protect him from contact with interior surfaces having temperatures as high as 160°F, air temperatures as high as 113°F.

(5) The Radiation Environment

(a) Solar Radiation

Adjustable protection shall be provided for the eyes against direct solar radiation - particularly at the ultra-violet end of the spectrum. Consideration should be given to the alleviating effects

of the vision medium (e.g. multiple windshield panes).

((b)) Hard Radiation

No protection will be required for the planned orbits.

((6)) Terminal Survival Environment

Survival capability for landing anywhere on earth shall be provided for a period of at least 72 hours. A signalling device having a 250 mile range and a life of 72 hours shall also be provided.

The efficiency of the crew in pursuit of the 14-day orbital mission is also influenced by the following factors:

((7)) Work station arrangement and intelligence display.

((8)) Internal and external vision provisions.

((9)) Rest and exercise accommodations.

((10)) Nutritional Requirements

The nutritional requirements for a 14-day mission based upon a consideration of solids and liquids are:

((a)) Water

2200 ml/da/man - may include fruit juice, hot beverages and drinking water.

2200 x 3 x 14 = 92.5 liters = 92.5 kg 203 lbs.

((b)) Food

The requirements for the normal man are 3000 cal/da average which is available from approximately 1540 gm (51 oz) of mixed diet consisting of protein, carbohydrate, fat, and 50% H_2O. The average caloric content is 6 cal/gm dry weight.

1540 x 3 x 14 = 64.7 kg   142.3#

Frozen flight dinners may provide this since warming facilities are available. Swallowing of food is effected by muscular effort and may present no problems. The problem of weightlessness requires containment of the food to prevent "floating" in the cabin. The food may be provided alternatively as a fluid or semisolid (available commercially as Gevral, etc.) placed in plastic containers to facilitate handling. Products of this type represent a major compromise with accepted standards on the basis of palatability, not on the basis of nutrition. The use of these dietary products requires less weight and space.

((11)) Personal Hygiene Requirements

Consideration has been given to the physiological, psychological and social aspects of sub-optimal personal hygiene for 14 days. Bacteria present in the normal skin and mouth in selected subjects presents no physiological hazard unless a break in the skin or compromise

in bodily defense mechanisms occurs. This requires supportive care, provision for which is being investigated.

((a)) Cleansing

Oral hygiene 5 ml proprietary mouth wash and 5 ml water - to be disposed of in the waste container

10 ml x 2/da x 3 x 14 = 840 gm

Bathing is accomplished with the use of packaged fresheners which are available commercially or treated paper towels (moisturized with and without detergents) may be used.

28 oz/man x 3 = 840 gm

Shaving is accomplished with a battery powered electric shaver.

((b)) Elimination constitutes a series of individual problems which are outlined below.

Urine

Daily volume 1500 ml/man

1500 x 3 x 14 = 63.00 liters   63.0 kg

Skin Secretions

Water - 600 ml is average for 24 hours with an eight hour work cycle. Muscular activity can increase this to 2500 ml in one hour for the initial hours of activity and at normal ranges.

600 x 3 x 14 = 25.2 liters   25.2 kg

Lung - Respiration

Water as vapor and droplet estimated to be 360 ml/man/24 hours.

$360 \times 3 \times 14 = 15.12$ liters or 15.1 kg

CO_2 is given off at the rate of 7-8 gms/24 hours. This would be increased with sweating or increased activity.

$8 \times 3 \times 14 = 336$ gm or 7.61 liters

This should be absorbed to give an atmospheric concentration no greater than 1%.

Fecal Excretion (Based on Restricted Bulk Diet)

Average daily elimination is estimated at 150 gr. wet weight. This is stored at 0°F. to reduce contamination of air with offensive odors. Space requirements are 0.02 cu. ft./man/day.

$0.02 \times 3 \times 14 = 0.84$ cu. ft.

Flatulence

One liter of gas is passed per day. The composition of this varies with the diet but principally contains CO_2, CH_4, H_2, and N_2.

Odor

Deodorization can be effected by using a cartridge

containing activated charcoal and resin in an air filter train. This also decreases bacteria content but does not provide adequate removal of CO_2. Estimates show 1¼ activated charcoal effective for deodorizing 100 cu. ft. for approximately 1 year.

(12) Emergency Kit

To contain specific remedies for the relief of general but possibly debilitating symptoms encountered in a 14 day mission. To include APC's, antihistamines, sedatives and stimulants selected with activity range appropriate to the duty cycle.

b. Provisions

The following crew provisions are provided in accordance with the foregoing criteria.

(1) Seating and Restraint:

A two position web-type seat-restraint system is provided (Bowring type). A 15° forward position is used for boost, a 10° aft position for all other phases of flight and orbit. For boost, re-entry and landing a torso garment is worn to firmly hold the crew to their seats and prevent undue movement under the force conditions listed in the requirements. Crew members are supplied with spring clips to keep themselves in place at their work stations while in the weightless state.

(2) The Internal Atmosphere

The pressure and composition of the air supply are in

conformance with the listed requirements. The internal pressure, and atmospheric components absorbed in breathing or lost through leakage are replenished from liquid oxygen and nitrogen sources. The air is processed to remove carbon dioxide, odors and water vapor. The reprocessing intake is placed within the toilet compartment. This system is reported in detail under "Environmental Control". The walls of the crew compartment are of honeycomb sandwich construction. Both skin surfaces are pressure tight providing dual pressure vessel reliability. R R

(3) Acoustic-vibration Attenuation

Acoustic attenuation is needed only for the boost phases and will be partially attained within the crew compartment walls. Ear plugs will be provided also for this phase and for the orbital phase to achieve relief from obnoxious sounds, real or fancied, which might develop.

(4) Temperature Control

Control of the internal temperature during re-entry exactly follows the DS-I concept. But for orbit, a closed system refrigeration cycle is needed to handle the equipment heat loads. This system is described further under "Environmental Control".

(5) Radiation

Windows will incorporate ultra-violet absorbing ingredients. Hard radiation does not appear to be a problem in the 150

mile orbit so no shielding is contemplated.

(6) Terminal Survival

In case of emergency, the escape capsule may come down nearly anywhere on the earth's surface. A modified global survival kit is contemplated which will give the maximum chance for survival and capability of evading the enemy. If downed in friendly territory, the crew will have the use of a radio rescue beacon having a 250 mile range and a 72 hour life.

(7) Work Stations, Crew Positions

The crew is placed forward in the Flight-capsule nose section for launch and return and also during the escape episode. The main crew compartment is separated from the capsule compartment by means of a pressure bulkhead with door loosely positioned to expedite emergency action. The concept is adopted that the crew will be compartmentized and, for an emergency, occupants of one compartment may have to be sacrificed. The decision to rescue members from the damaged compartment must be made by the survivors after they have considered prevailing conditions, i.e., availability of space suits, risk, etc.

Displays are required for the following reconnaissance systems.

(a) I.R. Detection: To detect rocket launchings.

(b) ELINT: To detect radio frequency emanations.

(c) Mapping IR, Radar, Photo: High resolution cooperative systems used for ground mapping.

The pilot's flight panels are essentially identical to those of the DS-I. By means of a mode selector, the horizontal situation display screen is also used for the IR detect and ELINT tasks.

A second work station is provided aft of the capsule pressure bulkhead for use in analyzing ground map data. Crew members rotate such that one member is off duty while the other two are on. The off duty member, thus can perform onboard maintenance, rest, or exercise. Division of crew tasks is reported in greater detail in later paragraphs. R

(8) Vision

External vision is dictated by the need for observing the runways during landing. Windows provided for this purpose will also permit visual observations in orbit. In addition to the pilot's wondows, two portholes are placed in the main crew compartment.

Internal vision will be augmented by means of fluorescent lighting.

(9) Rest and Exercise Facilities

A partitioned resting area is furnished at the rear of the main cabin. When clipped to a spring loaded restraint webbing, the crew member will have the tactile contact throught needed for rest in the weightless state.

To maintain muscle tone and cardio-vascular efficiency, it is recommended that crew members pursue a regimen of exercise. The area between the second crew position and the resting area is adequate for this purpose.

(10) Nutrition

A galley is provided for food storage. Food heating may be accomplished by using one of the onboard heat sources. Provision is made for all requirements.

(11) Personal Hygiene

In compliance with personal hygiene requirements given previously, a toilet area is furnished. Individual relief tubes are provided, plastic bags for feces, pre-packaged damp paper towels for washing, etc. The toilet compartment is isolated by means of corrugated sliding panel and an air intake leads directly to the re-processing system.

(12) Ingress, Egress

The main hatch is placed in the top aft portion of the capsule section. An auxiliary "break out" door is placed in the aft side of the main crew compartment. This door will only be used in case of emergency.

c. Contribution of Man

One of the major problems associated with orbital

reconnaissance systems is the transmission of adequate reconnaissance data without degradation to the ground. This problem is alleviated in the manned system by using the man to interpret and transform the data into condensed transmittible form. This capability is fully exploited in the design of the vehicle work stations and associated equipment.

Description of Work Stations

Console 1: IR Detection, ELINT

The IR detection equipment is in operation 50% of the time; ELINT approximately 10% of the time.

In the case of ELINT, evaluation for imminence warning, the system configuration requires computer programmed evaluation of signals within predetermined frequency band and signal characteristics. A single vehicle can supply only a small portion of the information that must be integr ed and collated on the ground to provide an estimate of the imminence of hostilities. The operator is alerted by the automatic system, evaluates the pattern of information, and decides whether or not to send a warning to the ground via narrow-band data-link.

For missile detection IR, it appears feasible and advantageous to include an automatic alarm system. An optical display with a memory capability can provide two dimensional tracking information. When the alarm circuit is closed, the operator can monitor the display and determine:

(a) The alarm was valid; that is, that a missile is in the field of view.

(b) The number of missiles in view.

(c) The character of the track.

The operator must reach a decision using the two dimensional trajectory display. Either the missile cannot be aimed at the U.S., or the missile may be aimed at the U.S. These decisions are based on judgment criteria which are not easily mechanized.

It appears relatively simple to integrate these two displays into a single console allowing them to be monitored by a single operator. They might well be displayed upon a ground map which would provide additional information for the operator's evaluation and screening functions.

Console 2: Photo, IR, Radar

Photo and IR are the sensors normally used; radar is reserved for emergency and war conditions.

We assume the crew to be trained photo interpreters who have received pre-flight briefing and simulator training.

Assuming (1) 10 areas of interest to be evaluated during each orbit, (2) that each area encompasses a square of approximately 24 N. miles in a side, (3) the orbit time for each vehicle averages 90 minutes, and (4) the vehicle will overfly USSR and China land areas on 2/3 of the orbits, it can be shown that an average of 1 area of interest must be presented on a display screen each 14 minutes for human

operator evaluation of all areas of interest to be mapped. By comparing the present photograph against a previous one in order to detect changes, it is feasible for a crew member to carry out a detailed interpretation of specific small areas on each area mapped before the orbit is completed. Thus, 27 orbital vehicles can photograph in daylight and provide evaluation of 1350 such areas each day, transmitting an evaluation of important findings over the narrow-band data-link.

Concurrently, the data interpretation crews on the ground can evaluate the data brought back to the ground or received via broad-band data-link. In this concept, detailed evaluation of imminence of hostilities is carried out in the air so that significant results can be transmitted immediately to the ground for overall corelation and evaluation. Order of battle and technical intelligence are carried out after each vehicle lands.

Duty Cycles

It is assumed that reconnaissance requirements will demand full-duty status of two men monitoring ELINT, Radar, and IR console displays during passage over USSR proper. It is further required that IR monitoring can be accomplished on all USSR operational waters which includes those of the entire northern hemisphere and those of the waters adjacent to Central and South American and those south of Hawaii as well.

During the passage over USSR operational waters, as well as over USSR proper, the IR watch is monitored by 1 man only and peak duty status of two men is needed.

A 24-hour day may be broken down into an eight-hour sleep or rest period and a 16-hour duty and semi-alert or relaxation period. This 16-hour period includes actual reconnaissance duties, maintenance duties, physiological activities (eating, cleaning, shaving, elimination, etc.) and relaxation.

The eight-hour rest period is chosen because it offers the conventional unbroken sleep and rest period. A mixed-duty, semi-alert 16-hour period allows good efficiency levels to be reached and maintained.

Interspersing top-peak work loads of reconnaissance duties with properly spaced, frequent rest periods or change-of-pace work periods will aid in keeping performance degradation to a reasonable minimum over the 14-day mission time. A three man crew satisfies these duty cycles.

Human Operator Functions

(a) IR Detection

If we assume that ocean areas in which missile might be fired from submarines at the U.S. or its allies will be monitored by this system, it appears that this display must be monitored approximately 50% of the time. In normal operation, this constitutes the largest single

item of the total work load. It can be handled by a single operator at any one time.

A design has been conceived for the IR detection display which assists the human operator to interpret the data and to transmit this information to the ground. It is reasonable to assume that some screening functions will be given to the computer and, as a result, the human operator's vigilance and detection tasks in operation of this system will be reduced.

(b) ELINT

This system is in operation approximately 10% of the time. The human operator's function will generally be restricted to imminence monitoring and to setting up equipment to record data for technical intelligence evaluation on the ground. If there are known radar signatures and frequencies to be monitored for imminence alerting, a warning system can be mechanized. In this event, ELINT summary data can be integrated into the display of the operator monitoring IR detection, leaving the second operator free for supplementary ELINT monitoring, sensor interpretation, or maintenance of malfunctioning equipment.

(c) Radar, Photo, IR

These systems are used cooperatively for ground mapping. The operator decides which of these systems will be used. He establishes the program for coverage of those particular areas which the command wants mapped, and

performs in-flight evaluation of sensor returns for particular high-priority areas on which the command requires immediate information. During hostility alert periods, there is capability for expanding the amount of in-flight evaluation of imminence and order of battle data derived from ground mapping.

Similarly, this capability can be employed for post-strike surveillance and enemy order of battle after the start of the war.

(d) Maintenance

A cursory analysis indicates that the crew has sufficient time, under normal operating conditions, to accomplish some in-flight maintenance. A trade study will be undertaken to evaluate the gains in system reliability and operating costs which can be thus realized, in comparison with the weight and volume penalties involved in providing work space, spare parts, and test equipment.

4. Communications

Narrow Band HF Transmitter:

There must be a provision for rapid transmission (within a few minutes) of "critical" data over a long range, secure transmission link.

The transmitter operates on the HF (3-30 mc) band, weighs 170 lbs.,

occupies 3 ft.^{3}, requires 400 W input, and produces 100 W output. Information bandwidth will be on the order of 50-100 cps.

Wide Band Reconnaissance Transmitter:
A wide band data link is required. This is provided with a high resolution, 6 mc bandwidth transmitter which communicates all data in one pass over the ZI.

The transmitter weighs 140 lbs., occupies 2-2/3 ft.^{3}, requires 450 W input power, and produces 50 W output.

UHF Voice Transceiver:
The UHF Voice Transceiver is provided as a general purpose transceiver principally useful in tower communications at landing. Also useful as a back-up around-the-world link by voice communication with friendly command stations and towers having access to WS 433L or WS 456L type world-wide communications systems.

This is a transistorized ARC-34 type transceiver weighing 40 lbs., occupying 1 ft.^{3}, requiring 200 W input power, and provides 50 W RF power. The transceiver has the capability of decoding pulse modulation to operate as a command receiver.

Rescue Beacon Transmitter:
All manned vehicles need a beacon transmitter to aid search parties in case of emergency landings in unscheduled areas. The transmitter is operated by the crew by selection or through automatic contact with land or water.

3. GROUND SYSTEMS AND SUPPORT

a. Introduction

Ground system planning for this reconnaissance system is based upon the vehicle as described in the previous section and the following operational requirements:

Utilization: Twenty-seven gliders are in orbit at all times. Mission duration is two weeks.

Number of Bases: Two

Launch Rate: Two per day average (one per base). Capability for launching one additional vehicle per day for five days is required.

Reaction Time: Time of firing will be announced at least one day before launch.

Vulnerability Allowable: No protection required against enemy missile or bomber attack.

Recycle Time: Gliders two weeks; first stage boosters one week.

Vehicle Life: Gliders thirty flights; first stage recoverable boosters two hundred fifty flights.

Large-scale operations and equipment are required to carry out these requirements. On-base assembly is necessary for gliders and second stage sections of the vehicle, due to the size of these units. First stage boosters are flown in, but large

facilities and equipment are required to prepare them for and accomplish final assembly of the vehicle. The large quantities of cryogenic propellants used daily may justify on-base production of these items. Post-flight servicing and rehabilitation of first stage boosters and gliders are major operations in their own right.

A stock of completed vehicles is maintained for emergency launch requirements. Vehicles for the normal launch schedule go directly to the launch area. Two vehicles are prepared for each firing to assure deployment of the required force in orbit.

The general concept for accomplishing maintenance on the orbital Reconnaissance Vehicle coincides with that already descibed for the ICBM in Part III-A. Any differences between the two maintenance programs will be primarily those of degree or detailed accomplishment, rather than changes in basic principles.

Fundamental quantities upon which the ground system planning is based are as follows. Equipment quantities are based on wearout only; no allowance has been made for losses, failures or aborts.

Force Size	
Gliders	64
First stage boosters	24
Annual Replacements (Wearout Only):	
Gliders	24
Second Stage boosters	730
First stage boosters	0.2

Launch Sites: (4 per base) 8

Personnel

Flight 114

Ground (direct and supervision) 5000 - 6000

b. Sequence of Operations (Same at Both Bases)

Equipment arriving at the base is channeled into hazardous and non-hazardous areas, where receiving-inspection locates any package damage that may have been sustained.

New first stage boosters are flown to the base. They are serviced, checked out and reworked if necessary, in the same manner as recovered boosters. Second stage components are shipped in large sections for on-base assembly. Tankage is assembled in large jigs. Rocket engines and other components are attached and the completed stage is checked out prior to shipment to storage or vehicle assembly.

Glider wings are joined to the fuselage and any components which are received separately (retro rockets, igniters, etc) are installed. Functional tests are performed prior to acceptance.

The three built-up sections are joined and checked out in the horizontal position on a large strongback which also functions as a transport dolly and erection beam for the completed vehicle. Vehicles are then moved by rail to storage hangars or direct to the launch area.

On arrival at the launch pad, the strongback is engaged with

trunnions on the launch platform and erection mechanism, and elevated to the vertical position. After the vehicle has been secured to the launch platform, umbilicals are attached and the strong-back is lowered and removed. The weapon is now ready for fueling and crew embarkation.

During the launch operation, which is sequenced and monitored by the control center, confidence checks are made on critical vehicle subsystems and all communication and military equipment subsystems.

Countdowns of the scheduled and back-up vehicles proceed simultaneously. Flight crews are removed from the remaining vehicle immediately after successful launching of its mate. Defueling is then accomplished. The vehicle is held for the next scheduled launching,or malfunction correction is initiated,as applicable. The launch monitor equipment indicates whether any faults which may occur are in the ground or flight equipment, and whether safety of flight is involved.

After the first stage booster has completed its mission and landed, it is towed on its landing gear to a de-fueling ramp. Mobile fuel tankers are provided to receive all remaining fuel, and a high-pressure nitrogen supply is provided to purge the fuel system. The booster is then processed through inspection and towed either to storage or to reconditioning facilities.

The glider is retrieved by specialized recovery equipment after

landing and taken to a water wash-down and crew disembarkation building. Medical facilities are provided at this location. Thereafter, the glider is towed to a data-handling facility for removal of data packages, and then to inspection for disposition. It is recycled either through repair facilities or direct to storage. All of the major foregoing steps are summarized in the Sequence of Events, Figure IV.A- 17.

c. Base Complex

The two operational bases provided for this system are widely separated to effect spacing of gliders into orbit; therefore all facilities are duplicated at each of the two bases. Location of these two bases is approximately 1000 miles apart along the 40° N. parallel of latitude; and they are situated to fire either north or south into polar orbits.

A runway with automatic landing installations and arresting gear is used for recovering both the glider and the first stage booster.

The non-hazardous area of the base includes an administrative building, and glider and booster assembly and maintenance buildings. The hazardous operations are seperated from the rest of the base by revetments and distances in accordance with the safety regulations for the various materials being stored and handled. Facilities for the inspection, storage, and mechanism installation of solid retro rockets are provided in such a way that the quantities of propellant in any one location are kept at a minimum and redundant buildings are provided so that an accident will not

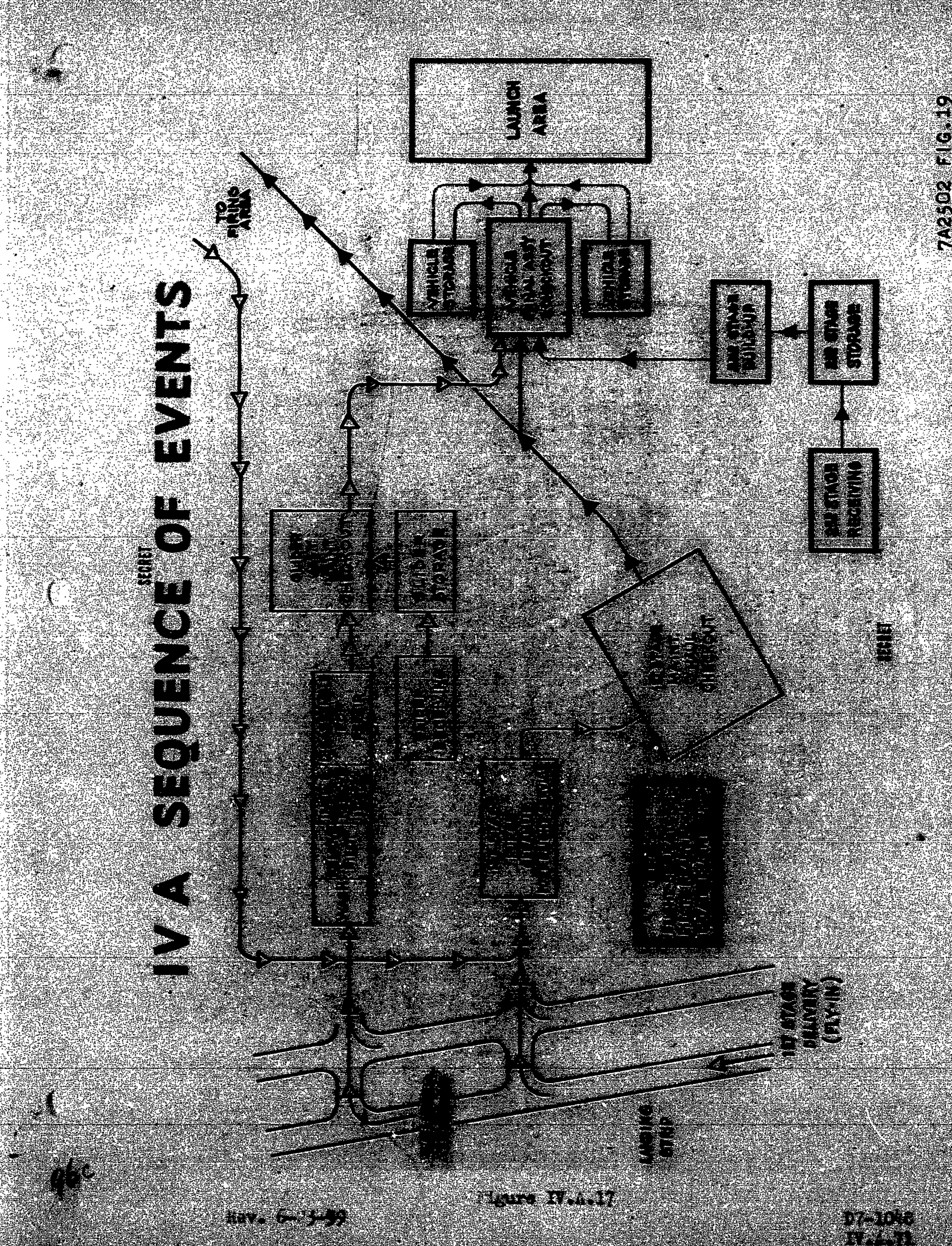

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Figure IV.A.17

halt production. Cryogenics are produced on the base. Propellants and other expendables are transferred to the point-of-use and local storage facilities as needed.

Final assembly and check-out of the completed vehicle is accomplished in redundant, separated buildings. From these buildings rail systems for transporting the vehicles extend to the launch sites. Each site includes a pad, blast deflector, fueling and servicing facilities, launch platform, erection mechanism, and a launch control building. After necessary connections have been made, the vehicle with its strong-back is erected to a verticle position.

A vertical static firing stand with a wet-type blast deflector is provided in the launch complex area for full-thrust tests of the first stage liquid booster when required. A separate control building services this installation.

d. Ground Cooperational Equipment

This category of equipment is defined as those items and facilities directly involved in vehicle launch, flight or recovery operations.

For the Orbital Reconnaissance Vehicle, major items include tracking, communications, and data processing equipment peculiar to this system, launch platform, autocollimator, and launch monitor and control equipment.

e. Ground Support Equipment

Items of support equipment required after factory completion of components, but not directly associated with the operational

firing aspects of a weapon, fall into this category. For the Orbital Reconnaissance Vehicle they include handling fixtures, dollies, beams, slings, work stands, special tools, major assembly test sets, functional checkout equipment, recovery vehicles, tugs, switching locomotives, missile covers, decontamination equipment, shipping containers and servicing equipment. Items of special interest are mentioned below.

Strongback (Figure IV.A.18)

A strongback with rail trucks is utilized in this ground system concept to permit horizontal assembly of the vehicle. Subsequent studies have indicated that vertical final assembly may be more economical from a system stand point. Vertical assembly would eliminate the strongback and substitute a smaller, lighter, rail-mounted dolly upon which the vehicle would rest in a vertical attitude from assembly thru storage, transport and launch.

Erection Equipment (Figure IV.A.19)

The illustration shows one type of erector which has been considered. Vertical final assembly of the vehicle would eliminate the requirement for erectors entirely.

Crew Access Equipment

Provisions are required for crew access to the glider and first stage booster a few minutes before launch. A separate tower may be used (and is required for the vertical assembly concept). Incorporation of crew access provisions in the strongback or erector is under study for the horizontal assembly concept.

7A2502 FIG.16

Figure IV.A. 18

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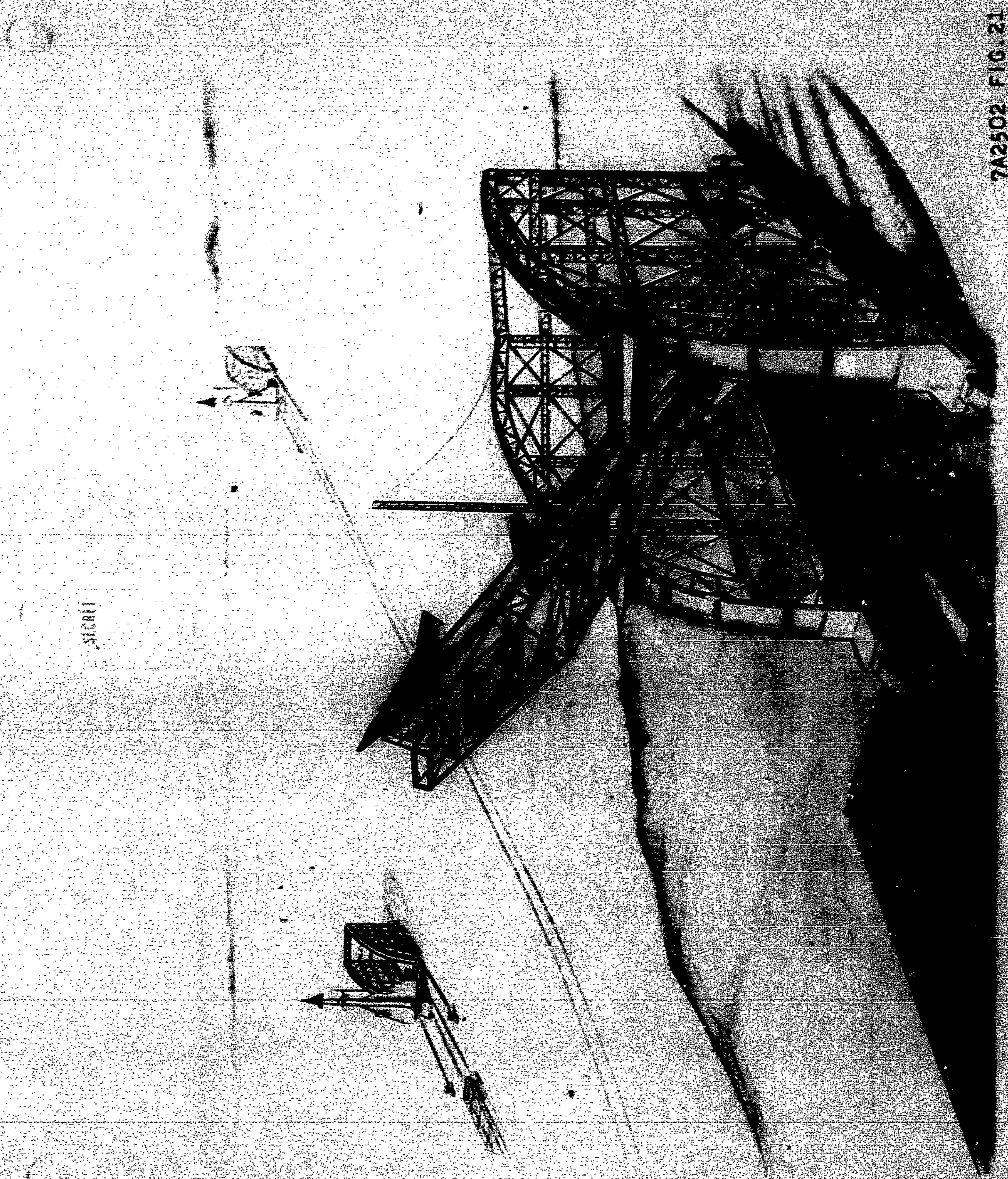


Vehicle Erection
Figure IV. .19

100C

Tow Tractor

This unit is required to move the recoverable first stage during ground handling operations. A standard Air Force MB-2 Tractor will be adequate for this function.

f. Spares and Supply

As indicated in Part III-A, the Boeing Spares and Supply concept described therein is equally applicable to the Orbital Reconnaissance System. Differences would be only a matter of detailed requirements in distribution flow, quantities, rate of operation, etc. A comprehensive formal plan worked out to the necessary detail will be defined, once the firm requirement for such an operational weapon system has been established.

g. Personnel Support

The operational characteristics of the Orbital Reconnaissance System require the support of an advanced personnel subsystem. Flight personnel must not only be technically proficient in individual assigned duties but must perform these duties in concert with and as part of a team effort. Crew personnel are subject to rigid physical and psychological appraisal prior to acceptance for training. They will have previously demonstrated outstanding technical proficiency as pilots or crew members in high performance aircraft. Their training after acceptance will be a continuous program which develops and improves the skills, attitudes and stamina essential to successful mission accomplishment. Training devices which closely simulate the flight regime and crew environment supplemented by intensive system indoctrination will be the media for attainment of basic crew and individual

proficiency. Operational proficiency is acquired during initial orbital flights.

Maintenance personnel qualifications mirror the functional organization of the assembly through launch and recovery sequences. Personnel with essential skills and proficiency are the product of special training programs and extensive on-the-job schooling. The complexity of vehicle subsystems and the effect of their operability upon mission success impose the requirement for near perfect maintenance which can be attained only by utilizing and rehearsing personnel with advanced technical proficiency within a responsive maintenance organization.

B. ORBITAL GLIDE BOMB, 1 YEAR, UNMANNED

1. System Concept and Description

The orbital glide bomb weapon system consists of a group of unmanned orbiting glide vehicles, boosters and supporting subsystems. This system is capable of accurately delivering nuclear warheads upon enemy target sites with a minimum reaction time. The bomb vehicle is launched into a 300 nautical mile altitude orbit where it remains for a one year mission period. A "strike" command, from a control station, can initiate a bomb attack at any time during the mission period. Firing the de-orbiting rocket causes the bomb to follow an elliptical orbit path which intersects the atmosphere. Upon re-entering the bomb follows a glide path to the target. This weapon system is a natural growth from the ICGM, the only changes being those required by the new environment. The glider carries a 600 pound warhead. It uses a similar inertial plus radar map matching bomb navigation system to achieve 1,350 feet CEP, and follows a glide trajectory similar to that of the ICGM. It is designed to attack a wide selection of hardened point targets.

The bombs may be placed in either polar or near equatorial orbits. The system has greater coverage capability and faster commitment rate from polar orbits. However, the bombs must overfly the USSR and would cause severe political problems. Therefore, orbits inclined 25° to 35° to the equator have been selected for detailed study. These orbits do not overfly the USSR and yet the bombs can reach targets at 75° to 85° North latitude due to their aerodynamic turn capability. Any peace

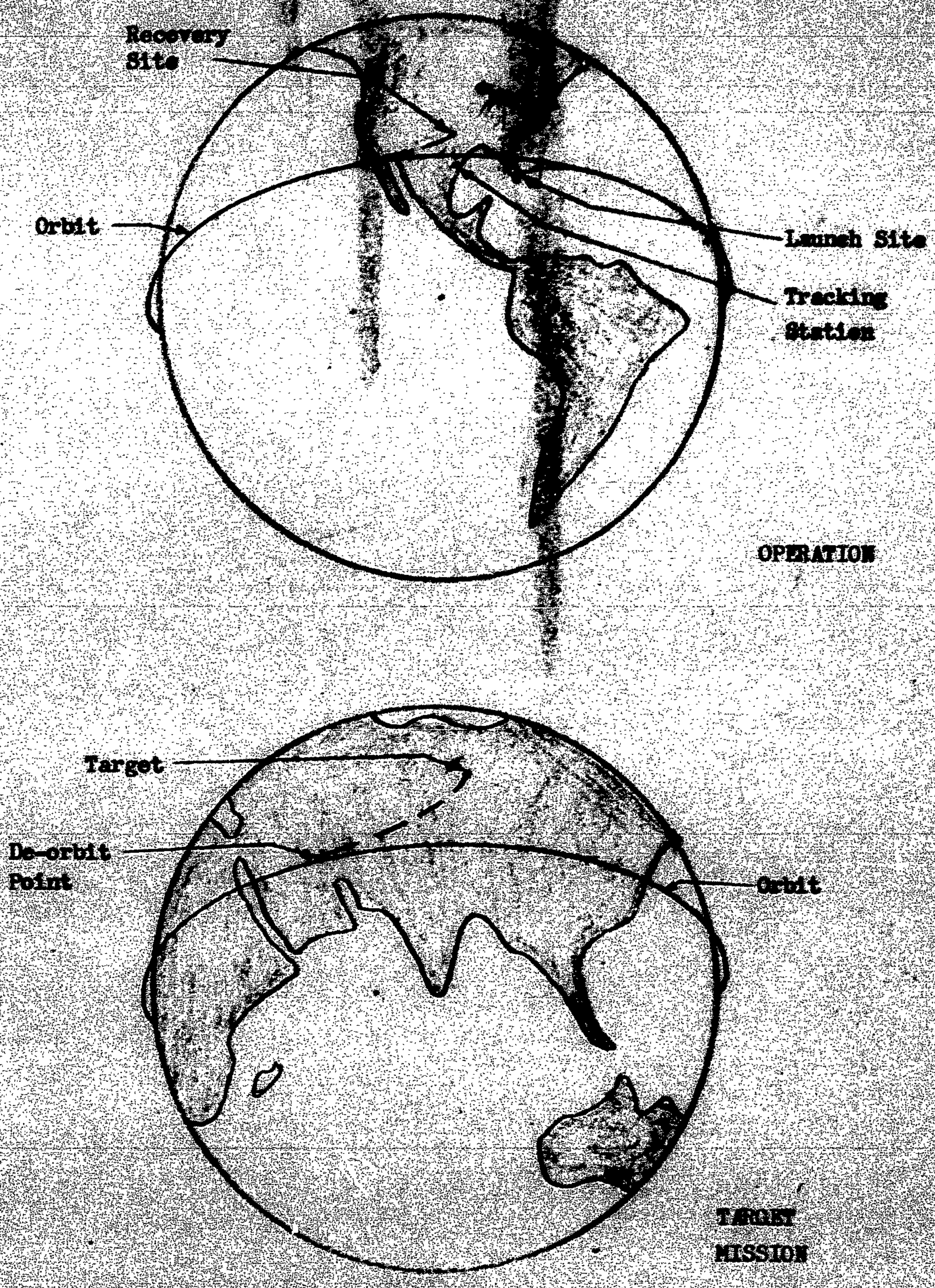


FIGURE IV B-1

ORBITAL GLIDE BOMB

time attack on the bombs will have to be made outside the Soviet Union. Only one third of the orbital planes are within air defense range of the USSR at any one time. Furthermore, the bombs cannot be detected from the USSR and its satellites until the fifth orbit, See Figure IV.B.2, giving ample opportunity for decoys to separate from the bomb.

The bombs are distributed approximately uniformly in longitude. They are projected into orbit as accurately as possible, then allowed to drift within the orbital band. Each bomb is tracked from the ground, its orbit determined and its future position computed. A central computer compares the bomb distribution with the target complex on a continuous basis and assigns a specific target to each bomb once each day. The assignment is made in such a way as to channel simultaneous attacks through corridors to saturate both area and local defenses. The target assignment and all necessary instructions associated with it except the command to attack are made when the bomb is over the United States. The system is on continuous alert; the attack command is given over a secure line of sight communication system which can reach every bomb within eighty-five minutes.

The bombs are recoverable for maintenance and for confidence "firings". They are launched on a routine schedule and remain in orbit until a failure occurs. Failed bombs are recovered as failures occur, and are replaced in orbit by new bombs. Redundant navigation, flight stability and power supply systems are provided to increase the probability of recovering the glider. The mean time to failure of the bombs should be about two years. Studies show that this will be difficult to achieve;

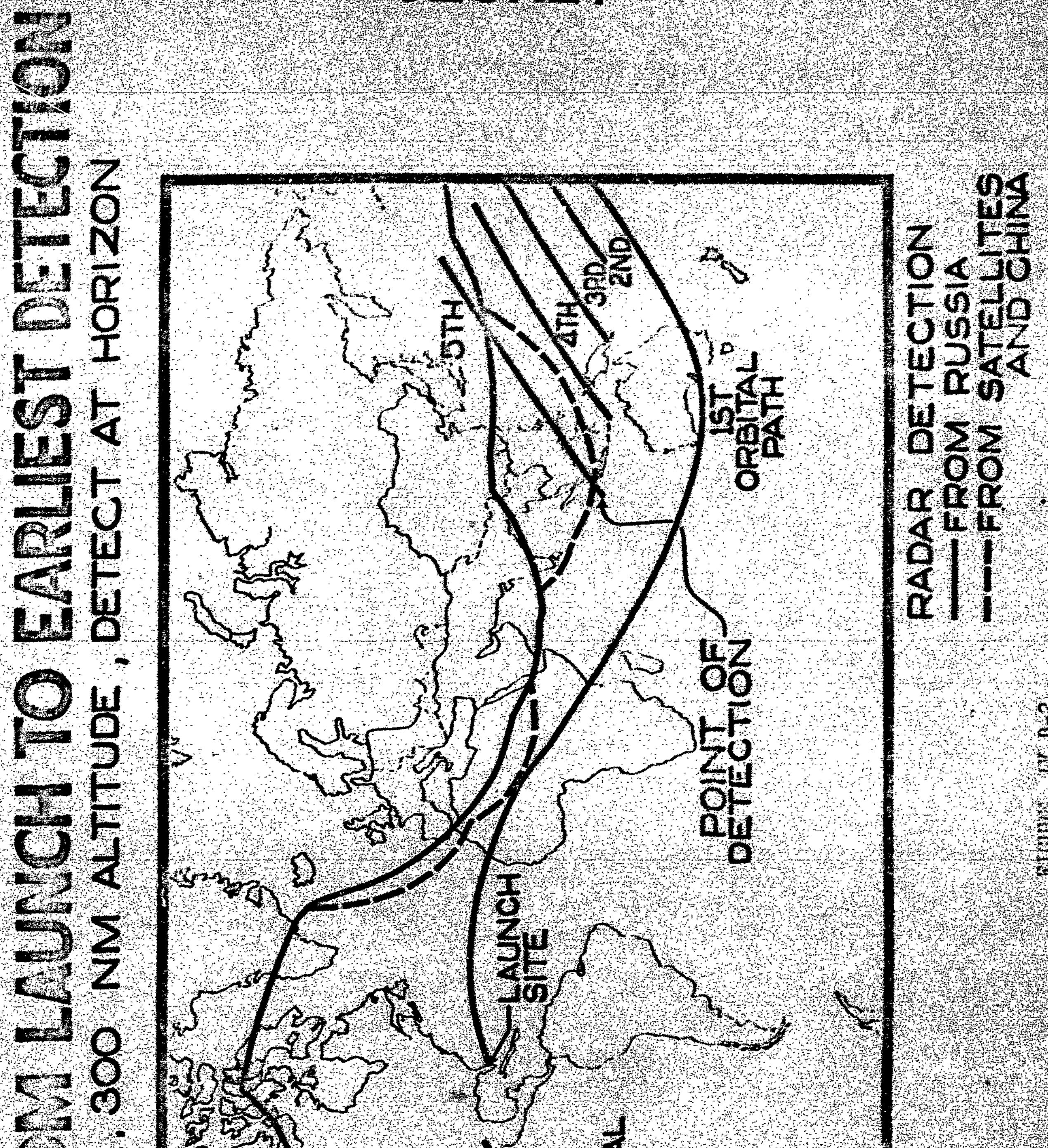


FIGURE IV.B-2.

Figure IV.B.2

but, the concept which minimizes the amount of equipment operating during the orbital phase will prolong the equipment life.

An alternate guidance system would include a star map matcher. The inertial system will be turned off until the command to attack is received, at which time, the star map matching system will search the star field and locate the reference stars. The inertial system will then be aligned using the star reference and attack initiated. This system avoids long inertial system operating times.

The orbital bomb together with the satelloid and orbital reconnaissance systems provide an aggressive defense posture that is complementary to the retaliatory posture of WS-133A. These systems can detect the enemy's "count down to war" and can strike his hardened control centers and similar strategic targets before he can initiate a full scale attack. The two offensive weapons can be used in either posture to complement each other, the orbital bomb being assigned to the hardened point targets and WS-133A to the area and industrial targets.

Decoys are provided to accompany the bombs in orbit. Interception of warheads can be made unprofitable in this way. Glide type re-entry decoys are also provided to accompany the warheads to the target.

2. System Configuration

a. Performance and Configuration

The orbital glide bomb is an unmanned orbital vehicle designed to remain in orbit up to one year. It has the ability to attack on command or return to a recovery site for service. Figure IV B-3 is a drawing of the bomb. A recoverable booster is used to launch the bomb plus five re-entry decoys and two orbital decoys to an altitude of 300 miles. Additional orbital decoys may be launched in groups of three. Final orbit correction is made by firing solid propellant trim rockets located in the interstage section. This section also contains the orbital decoys and solar cell-particle shield. The orbital decoys are launched after the orbit is established. The solar cell-particle shield is a dual purpose device and is erected when the decoys are launched. The solar cells provide not only solar power but by being located in the forward velocity quadrant provide protection against enemy particle attacks as described in Section II. The rear of the bomb is pointed forward while in orbit.

Upon command the vehicle will de-orbit and re-enter;and,is capable of gliding and maneuvering 3,000 miles laterally from the orbit plane. The particle shield-solar cell unit is separated during re-entry.

A landing gear and an automatic landing system is incorporated to recover the vehicle for necessary maintenance. To further assure recovery of the

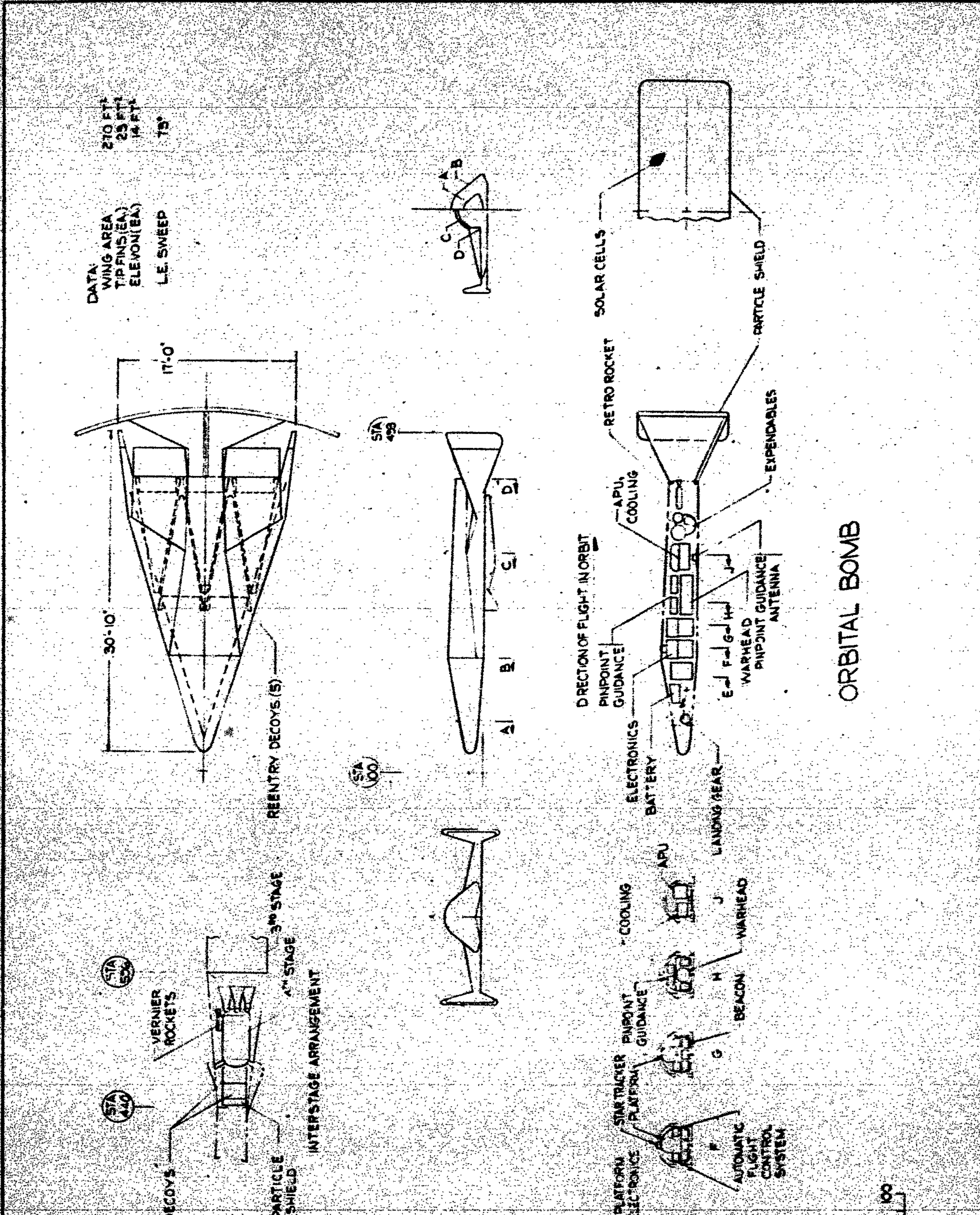

DATA:
WING AREA 270 FT²
TIP FINS (EA.) 25 FT²
ELEVON (EA.) 14 FT²
L.E. SWEEP 75°
17'-0"
30'-10"
REENTRY DECOYS (5)
STA 458
STA 100
A
B
C
D
SOLAR CELLS
PARTICLE SHIELD
RETRO ROCKET
EXPENDABLES
APU, COOLING
DIRECTION OF FLIGHT IN ORBIT
PINPOINT GUIDANCE
ELECTRONICS
BATTERY
LANDING GEAR
E
F
G
H
J
WARHEAD
PINPOINT GUIDANCE ANTENNA
ORBITAL BOMB
APU
COOLING
WARHEAD
PINPOINT GUIDANCE
BEACON
STAR TRACKER PLATFORM
PLATFORM ELECTRONICS
AUTOMATIC FLIGHT CONTROL SYSTEM
0
80
INCHES
STA 536
STA 440
VERNIER ROCKETS
3RD STAGE
4TH STAGE
INTERSTAGE ARRANGEMENT
ORBITAL DECOYS
PARTICLE SHIELD

Figure IV.B.3

vehicle, the navigation and flight control systems are provided with back-up systems. A 600 lb., 1/2-1 MT, warhead is contained within the vehicle for destruction of enemy targets. It is put into a positive disarm condition for recovery flight. Map matching radar is used to guide the vehicle to its target.

The basic vehicle design incorporates many features of the DS-1. However, the canopy has been eliminated and the body shape has been modified.

During launch the orbital decoys and solar cell-particle shield are stored in the interstage section. Five re-entry decoys are mounted on the lower wing surface. They remain attached during launch and orbit and are set free upon re-entry. A boost trajectory is used that is favorable to thermal heating of the bomb's lower surface, with decoys attached. The landing gear consists of a mechanical nose wheel and two aft skids similar in arrangement to DS-1.

Propulsion consists of a first stage recoverable booster and a second stage, non-recoverable booster. Five, small, solid propellant vernier rockets are contained within the interstage for final orbital correction. Solid propellant retro-rockets are installed in the aft section of the vehicle.

The internal arrangement incorporates variable density packaging with expendables aft and batteries, electronics

and warhead forward. The antenna for the pinpoint radar is located on the bottom. Cooling radiators are located in the upper wing surfaces.

PRELIMINARY WEIGHT STATEMENT:

Item	Weight - Pounds	
Wing	600	
Body	1,420	
Fins	310	
Control Surfaces	290	
Total Structure		2,620
Retro Rockets	560	
Vernier Rockets	240	
Total Propulsion		800
Auxiliary Power System (Including 50 pounds fuel)	680	
Reaction Control System (Including 15 pounds fuel)	80	
Hydraulic System	70	
Electrical System	210	
Total Secondary Power		1,040
Environmental Control (Including 115 pounds expendables)		555
Electronics		1,390
Flight Controls and Mechanisms		140
Landing Gear		280
Warhead Control		45
Warhead		*600
BOMB GROSS WEIGHT		7,470*

Decoys

Two types of decoys are provided; one to decoy the bomb while in orbit and the other during the attack. The orbiting decoy is an inflatable balloon-type decoy, weighing 220 pounds, with an appearance similar to the parent vehicle (See Figure IV.B.4). This decoy cannot be permitted to tumble, otherwise there will be sufficient scintillation of the radar and optical returns to discriminate it from the bomb, which does not tumble. For this reason a stabilization system has been placed in the vehicle. This stabilization system uses an inertial reference platform to retain a directional sense and a combination flywheel and jet stabilization system to keep the vehicle oriented. The system also has a sun and horizon tracker to sense three-axis orientation in space. At a pre-set time during each orbit the system senses the directions of the horizon and the sun and precesses the gyros in the stable platform to remove residual gyro drift.

The decoy also contains a beacon similar to the one in the parent vehicle in order to simulate the beacon returns of the parent vehicle. This beacon is interrogated each time the decoy passes over the control site. The clock in the decoy is re-set at this time.

The power for the beacon and stabilization system is furnished by solar cells located on the top side of the vehicle. Batteries store energy for use during the period when the decoy is in the shadow of the earth.

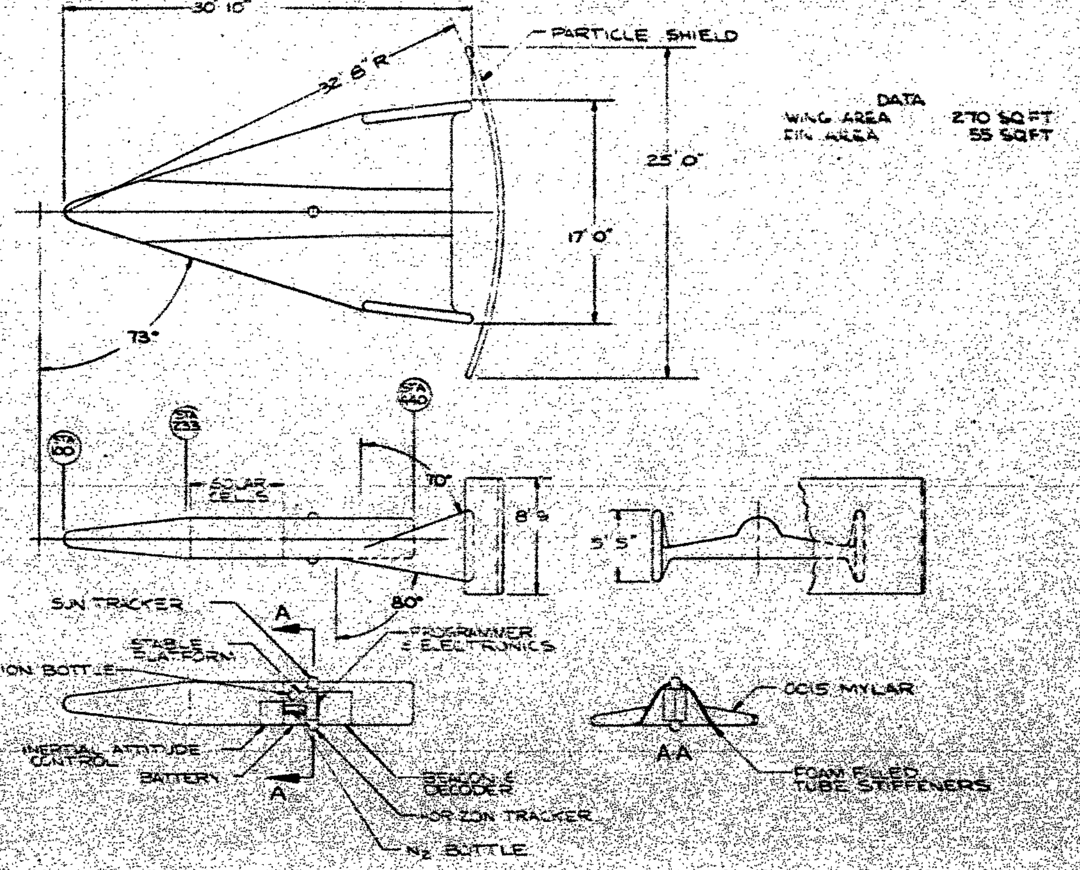
Two orbital decoys and five re-entry decoys are launched at the same time and by the

same booster as the parent vehicle. They are dispersed after boost burn-out. Additional orbital decoys are launched in groups of three by means of separate boosters. Five orbital and five re-entry decoys are used for each warhead in orbit. If enemy action or intelligence information indicates that more decoys are needed, they will be launched in groups of three.

The re-entry decoy is a small glide missile similar to the parent vehicle (See Figure IV.B.5) and are attached to the lower wing surface. After the de-orbit rocket has burned out (See Figure IV.B.3), the decoys are released and accompany the bomb until they are destroyed. The decoy contains a navigation system, a control system, and a flight programmer enabling it to follow approximately the same flight paths as the bomb. Natural dispersion resulting from the crude guidance used in the decoy is sufficient to give them a separation from the bomb. Five re-entry decoys are used with each bomb vehicle.

PRELIMINARY WEIGHT STATEMENT, RE-ENTRY DECOY:

Item	Weight - Pounds
Structure	290
Guidance	80
Flight Control	25
Electrical	45
Cooling & Pressurization	45
Surface Control	10
Power Supply System	55
TOTAL GROSS WEIGHT	550



ORBITAL BOMB SPACE DECOY
MODEL 814-4005

Figure IV.B.4

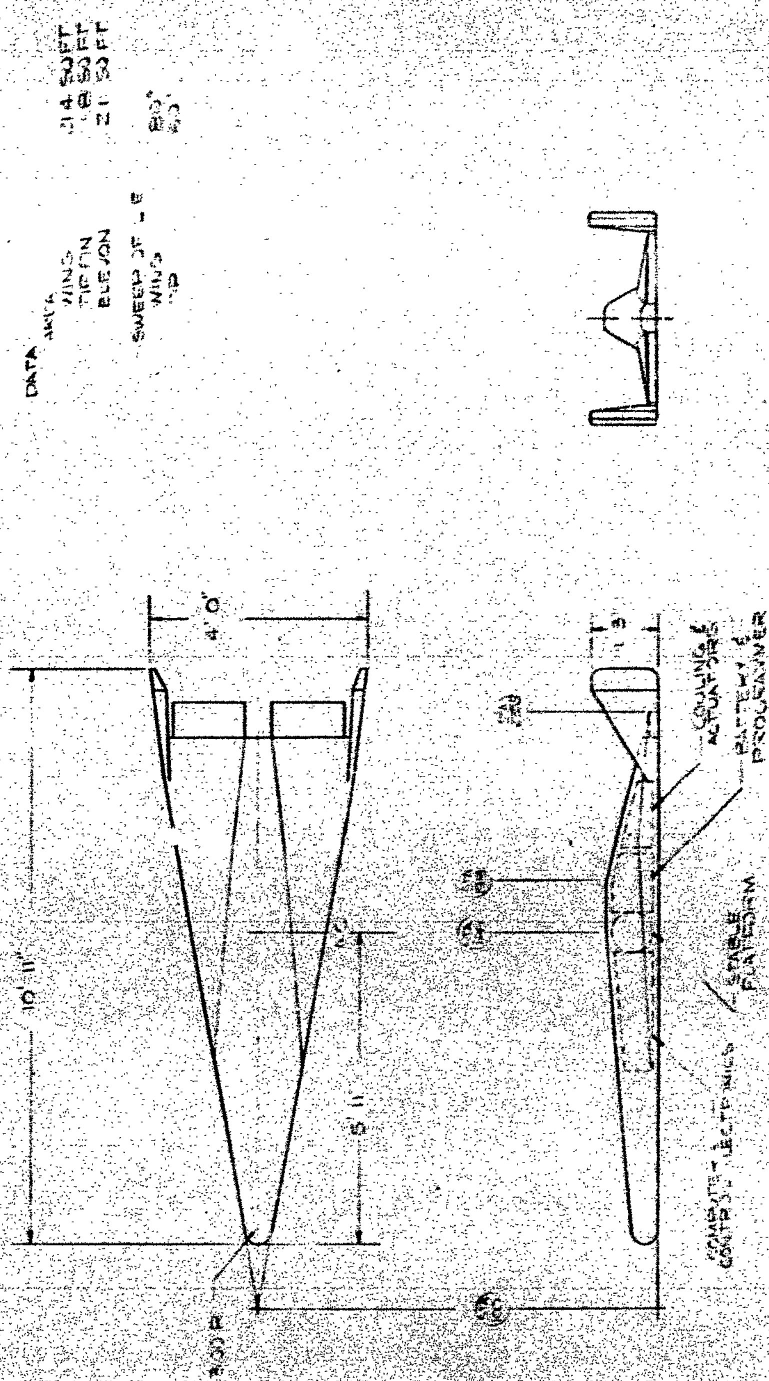

DATA
WING
TIP FIN
ELEVON
SWEEP OF L.E.
4' 0"
10' 11"
5' 11"
STABLE PLATFORM
COOLING & ACTUATORS
BATTERY & PROGRAMMER
ORBITAL BOMB REENTRY DECOY

Figure IV.B.5

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Booster System

The booster for the orbital glide bomb vehicle is a two stage booster. (See Figure IV.B.6) The first stage is recoverable. It uses liquid oxygen and liquid hydrocarbon propellants. The second stage goes into orbit with the glider and is expendable. It uses liquid oxygen and liquid hydrogen propellants. See Section V for more information on boosters.

The first stage attains a burnout velocity of 8,800 fps. The upper stage has been sized to place a 10,660 pound glider in a 300 N.M. altitude, circular, polar orbit.

WEIGHT STATEMENT:

Item	Weight - Pounds
Glider and Decoys	10,660
Second Stage	
Burnout	16,000
Propellant	47,300
Start Burning	63,300
First Stage	
Weight Empty	81,900
Pilot	250
Trapped Rocket Propellant	4,300
Turbojet Fuel	16,000
Propellant	432,000
Launch Weight	597,750

III A &

IV B

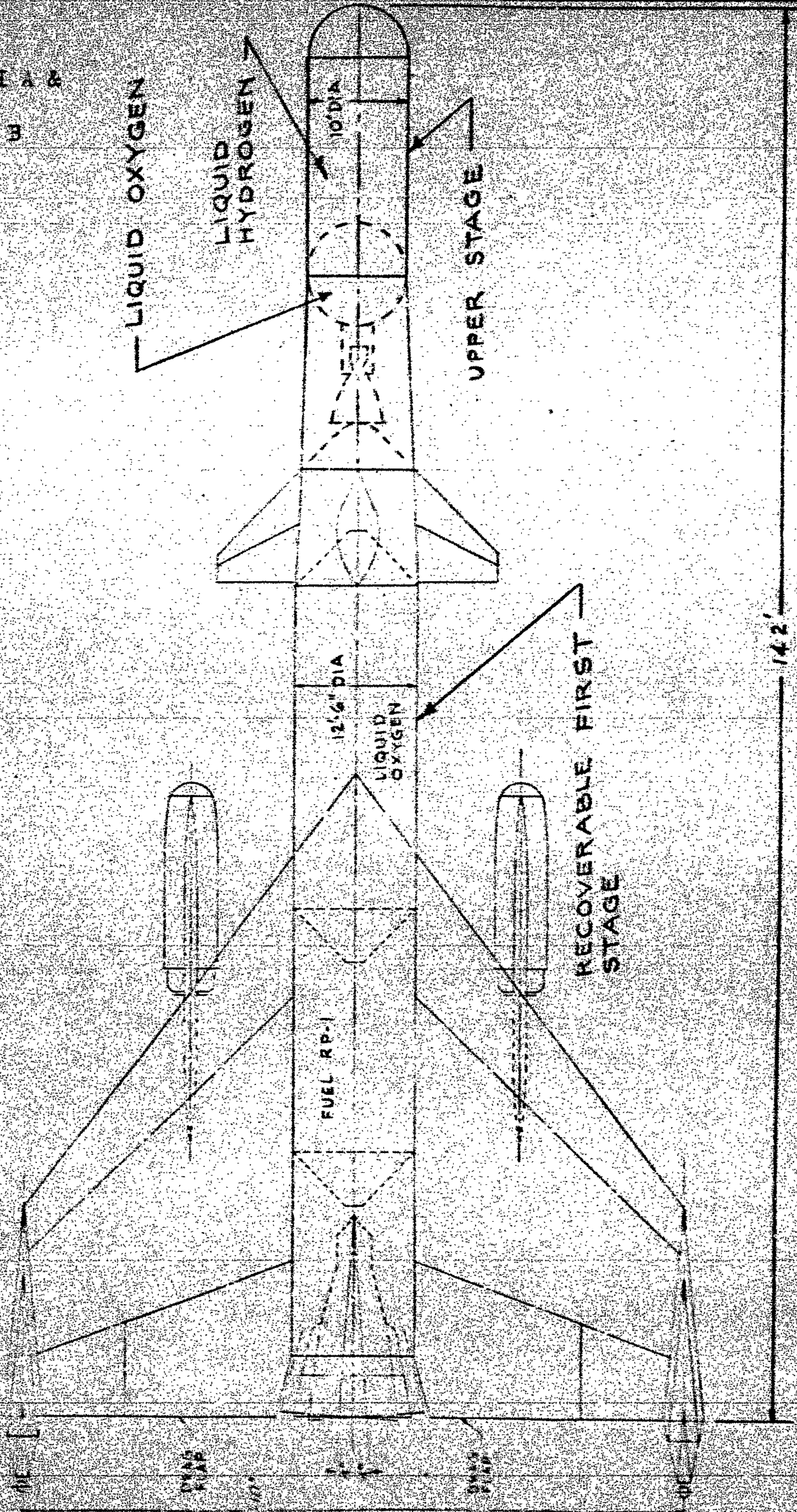


Figure IV B-6

b. Military Subsystem

Accurate terminal guidance is provided by a Pinpoint Guidance System. This system, proposed by Goodyear Aircraft Corporation consists of a map-matcher, an X-band radar, a flush Luneberg 360° scan, non-stabilized antenna, and a radar data stabilization unit. The programming and computing functions and present position and velocity data required to complete the terminal guidance operation are obtained from the inertial guidance system.

Operation of the Pinpoint Guidance System shown by the block diagram in Figure IV B-7 is as follows. The programming function of the digital computer initiates operation of the X-band map-matching radar approximately 100 N. Mi. from the target. The radar takes a picture of the ground and furnishes video information to the map-matcher where it is compared with a stored map of the fix point. Inertial position data from the motion stabilization computation and radar stabilization data are also supplied to the map-matcher. The output of the map-matcher therefore becomes a direct indication of inertial position error. This error information plus altitude information (obtained from the Pinpoint mapping radar) are utilized by the digital computer to generate position corrections in the proper coordinates for the inertial system.

The radar data stabilization unit utilizes vehicle

attitude data from the inertial system and the angular position of the radar scanner to provide information to the map-matcher so that the video return may be properly oriented. Motion stabilization is required because of the vehicle motion during the time required for the radar scan. This stabilization is obtained by feeding position data which is computed from inertially indicated position data and fix-point coordinate data supplied to the map-matcher.

The inertial guidance system guides the orbital glide bomb with an accuracy such that when the bomb passes over the check point, the check point is within a square
4 miles on a side. The Pinpoint Guidance System red- R
duces this error to less than 760 ft. CEP. From this R
point the inertial system guides the bomb to an esti-
mated bombing CEP of 1,350 ft. R

c. Guidance and Control

(1) General Description of Guidance System

The type of guidance in operation depends on the particular flight phase of the warhead vehicle.

During the launch phase the vehicle is controlled by a programmed inertial autonavigator system. This autonavigator is the same one which is later used during the attack on target.

After launch into orbit, the vehicle is tracked from

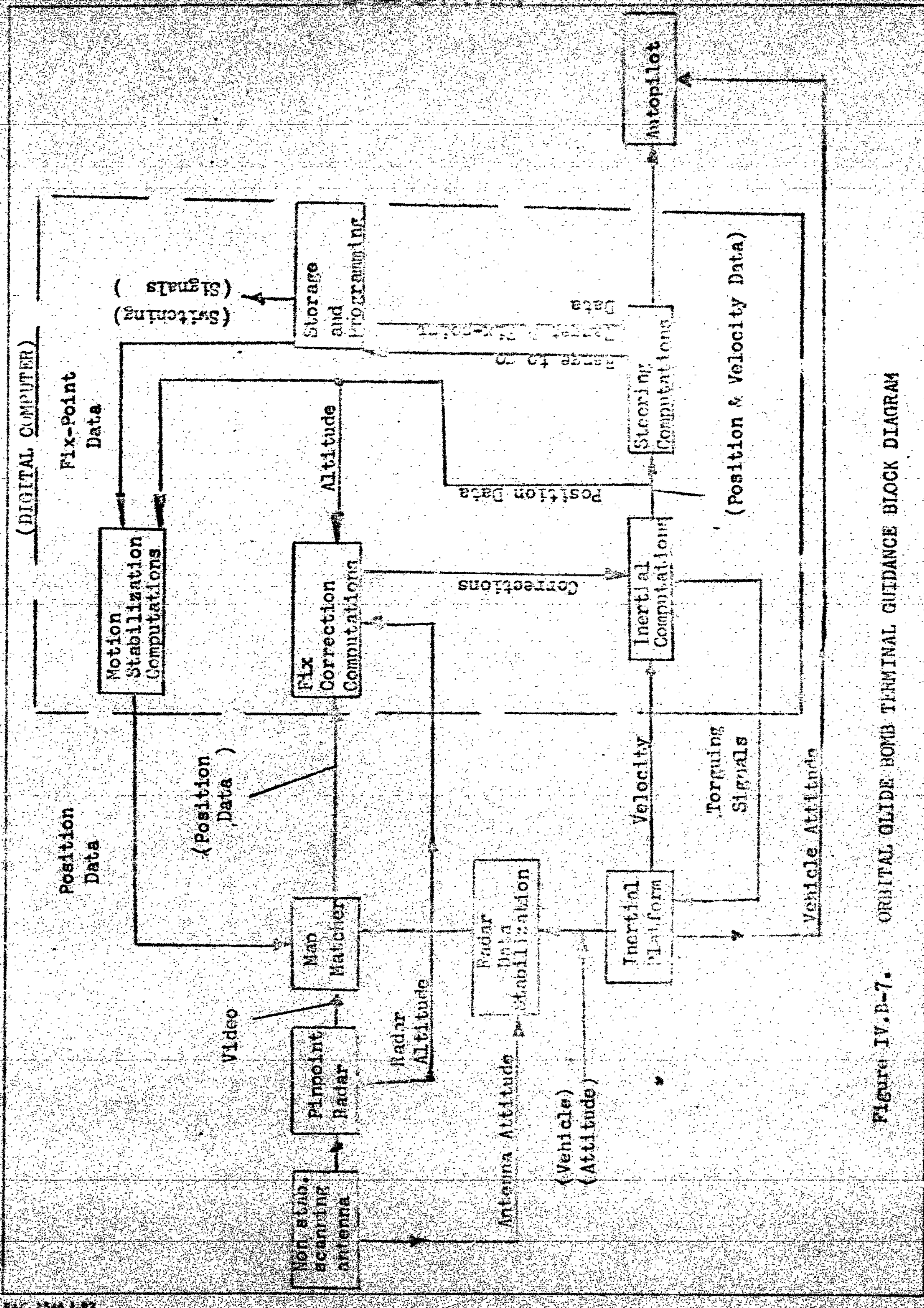


Figure IV.B-7. ORBITAL GLIDE BOMB TERMINAL GUIDANCE BLOCK DIAGRAM

the ground by a tracking station in the southern United States. A precision radar tracking station obtains a position fix on the warhead vehicle once every 24 hours. All data relative to the bomb orbit is stored at a ground computer station. Orbital trajectory parameters are computed from position data. These parameters are transmitted to the orbiting vehicle as it passes over the tracking station once a day. At the same time a precise clock in the vehicle is synchronized with earth time. A computer in the vehicle, utilizing the orbital data and the clock, can then compute its own position at any point in the vehicle trajectory.

An auxiliary guidance function during normal orbital flight is the alignment of the inertial platform for use for descent from orbit. A star tracker mounted on the platform takes a star fix once every orbit for this purpose.

Guidance during the attack phase (descent from orbit and guidance to the target) depends both on equipment in the vehicle and planning and computation on the ground prior to the start of hostilities. A computer on the ground determines the best plan of attack for each warhead vehicle and transmits the data necessary to accomplish this plan to the vehicles each day. This data includes: target and check point assignment, approach path coordinates, time and direction of

de-orbit. The inertial autonavigator supplies navigation data during the descent from orbit. A radar map-matching system takes a radar fix on the pre-assigned check point as it nears the target area. This fix corrects the guidance system and assures an accurate hit on the target.

When the vehicle is to be returned to base for maintenance, a similar procedure is used. The landing instructions are computed on the ground and transmitted to the vehicle as it passes over the tracking station. The inertial system brings the vehicle within range of an automatic landing system. The landing system utilizes a long range radar for acquiring the vehicle as it approaches the landing site and for transmitting landing commands to it.

In case of failure of the basic navigation system during orbital flight, a back-up, lower accuracy guidance and control system is included in the vehicle for bringing it back to base.

(2) Guidance and Control Systems

(a) Launch Phase

A block diagram of the guidance and control system during launch is shown in Figure IV B-8a. The star tracker is used to align the stable platform prior to launch. The basic navigation computer using data obtained from the inertial platform and instructions from the launch programmer supplies

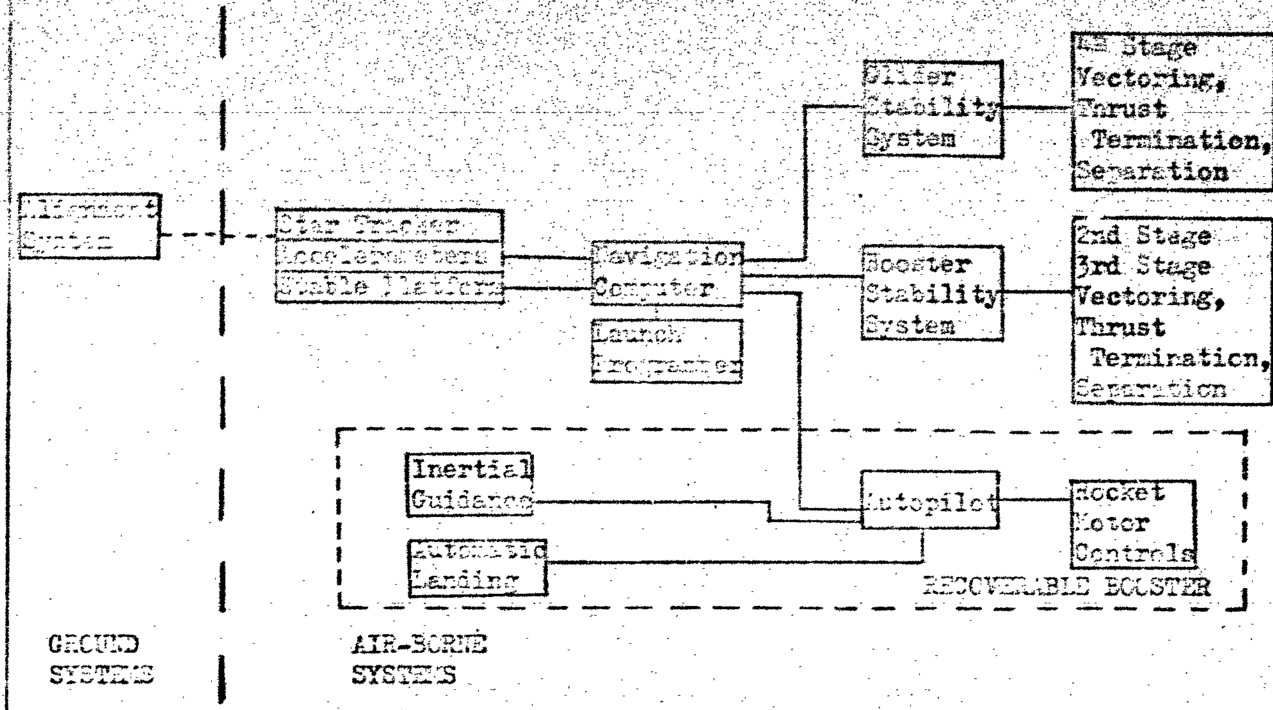


Figure IV.B-8.a. Guidance and Control: Launch Phase

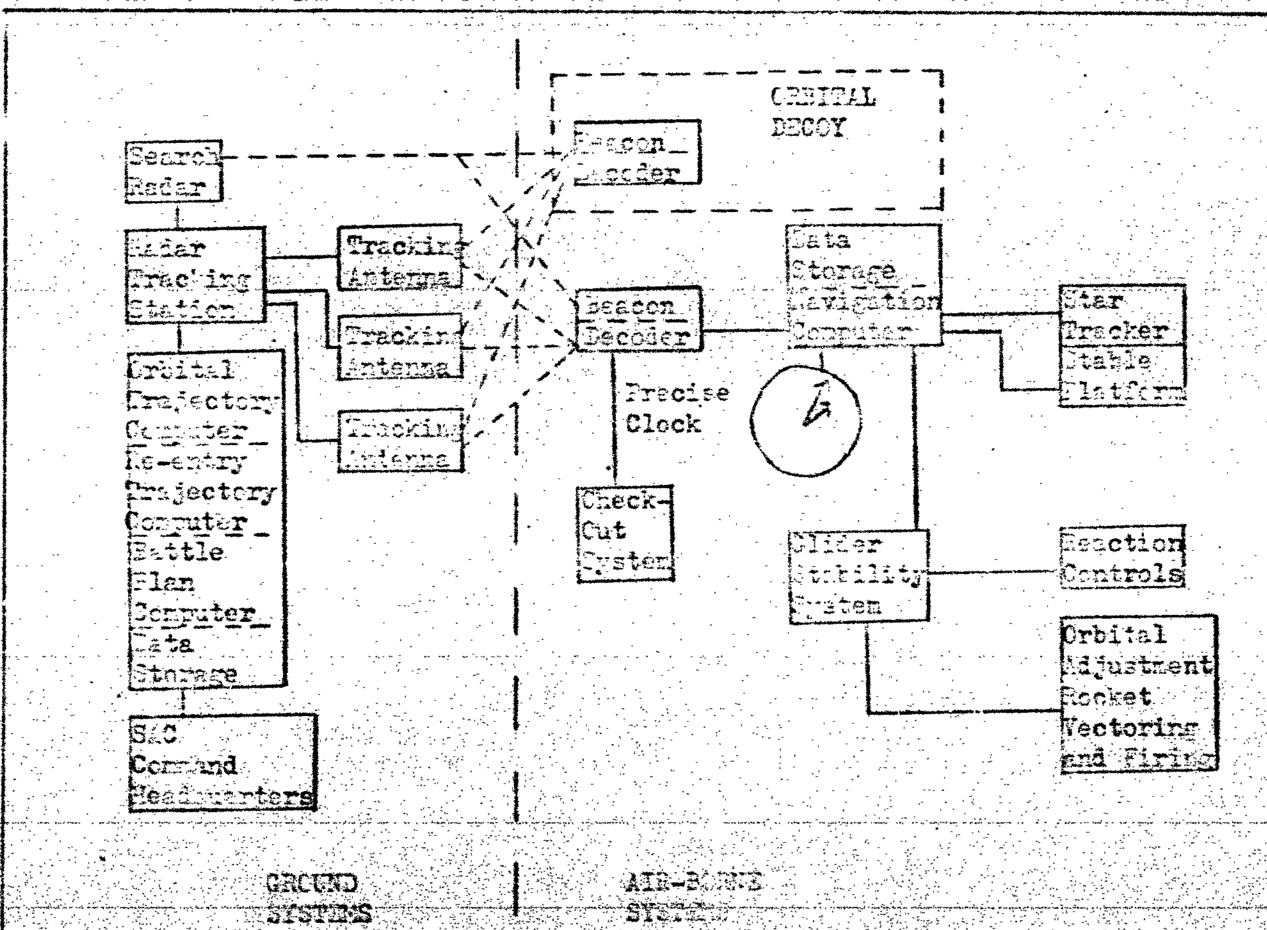


Figure IV.B-8.b. Guidance and Control: Orbital Flight Phase

control information to the first stage recoverable booster, subsequently to the 2nd and 3rd stage booster stability system and finally to the glider stability system. The recoverable booster has its own inertial guidance and automatic landing system.

(b) Orbital Flight Phase

The orbital flight guidance system is shown in Figure IV B-8b.

The radio tracking system is an advanced X-band, CW position-plus-rate tracker. Some of the key circuits have already been breadboarded at General Electric. This system reads range rate and angular rates directly as in the latest Atlas equipment, utilizing three hardened antennas in an "L" configuration. The base lengths are longer, however, to increase the accuracy of the rate data.

Measurement of position across long interferometer base lines greatly reduces the effects of bends in the phase front caused by slowly-changing moisture masses. The feature that makes this system practical is a novel monitoring loop which permits compensating for phase changes in the waveguide runs between antennas. Angular ambiguities are eliminated by beamwidth selection and the use of a multiple-frequency reply signal. Range measurements are made by propagation of appropriate phase

modulation, coded to eliminate range ambiguity.

A different form of phase modulation carries ground-generated commands to the warhead vehicles. A random frequency jitter, balanced about the suppressed center frequency, is introduced for increased security.

The ground orbital trajectory computer, besides calculating orbit parameters and vehicle position, directs the antennas for acquisition.

New position and rate data are then read directly in digital form without the necessity for prolonged smoothing. After a short dwell time during which the computer corrects stored orbital data and updates the memory banks in the vehicle, the track antennas are free to contact another orbiting warhead.

This same system is used to track and keep track of orbital warhead decoys.

An X-band, CW search radar, operating with the track beacon-decoder, acquires the warhead vehicles first time in orbit, and puts the ground-computer, track-radar complex on target.

The navigation computer in the vehicle computes vehicles position using the stored orbital parameter data obtained from the ground and the precise

clock. In addition, it directs the star tracker to align the stable platform once every orbit. It supplies data to the glider stability system for attitude control. Data for firing the orbital adjustment rocket is generated on the ground and used by the navigation computer to control the firing.

(c) Attack Phase

In order to saturate enemy defenses to the maximum extent, all attacks on a given target area should be made approximately simultaneously. This requires that target assignments to warhead vehicles in orbit must be correlated with the relative positions of these vehicles in orbit. These target assignments must be pre-computed in such a way as to result in the required target saturation. Since the relative positions of the warheads change radically during the course of the year, the assignments must be re-computed periodically.

The battle plan computer shown in Figure IV B-8b makes this computation and transmits the resulting target assignments to each warhead vehicle daily.

The computation proceeds by establishing 100 cells, each about 1,000 miles on a side, moving with the warhead vehicles. The location of each satellite is calculated with sufficient accuracy to assign it

to a cell in which it will remain for one day. The Russian target complex is then broken into grids with various quantities of warheads required per square. The computer selects the square requiring the largest number of warheads and searches the cells for that cell containing the largest number of warheads. It then adds adjacent cells until the total requirement for that square is met. This process is continued until all squares are handled.

Each warhead is assigned a particular target within the square based on what target information is stored in the vehicle.

Each warhead vehicle must have proper instructions for re-entry, approach to the target along a specified corridor and navigation to the proper radar check points. The Re-Entry Trajectory Computer on the ground performs the required computation and transmits data in a form which the navigation computer can use for making the attack.

The above plan assumes only a geographical priority to target assignment. It is anticipated that it will be possible to modify this battle plan to include temporal priority in the assignment of targets. I.e., target assignment will depend on how long it will take to reach enemy territory from the

time hostilities start.

The Data Storage System of the ground computer stores the following information:

1. Orbital parameters of all warhead vehicles for computation of position to 1 mile accuracy. Rapid access required.
2. Orbital parameters of orbital decoys for prediction of time and position of arrival over the tracking station once a day.
3. Battle plans, including target data, approach corridors, optimization program.
4. Performance characteristics of vehicle (retro rocket impulse, flight profiles, maneuver capability).
5. Target check point maps stored in each vehicle.
6. Vehicle history for maintenance purposes.

All of the above actions take place prior to initiation of hostilities. An actual attack awaits a command from SAC Headquarters as shown in Figure IV B-8c. This command may be received at any place in orbit. The Attack Program Sequencer then initiates action to attack. The navigation computer, using the data already stored for this purpose, controls each operation in the proper sequence. For example, when Time-Remaining-Until-De-Orbit for this particular revolution around the

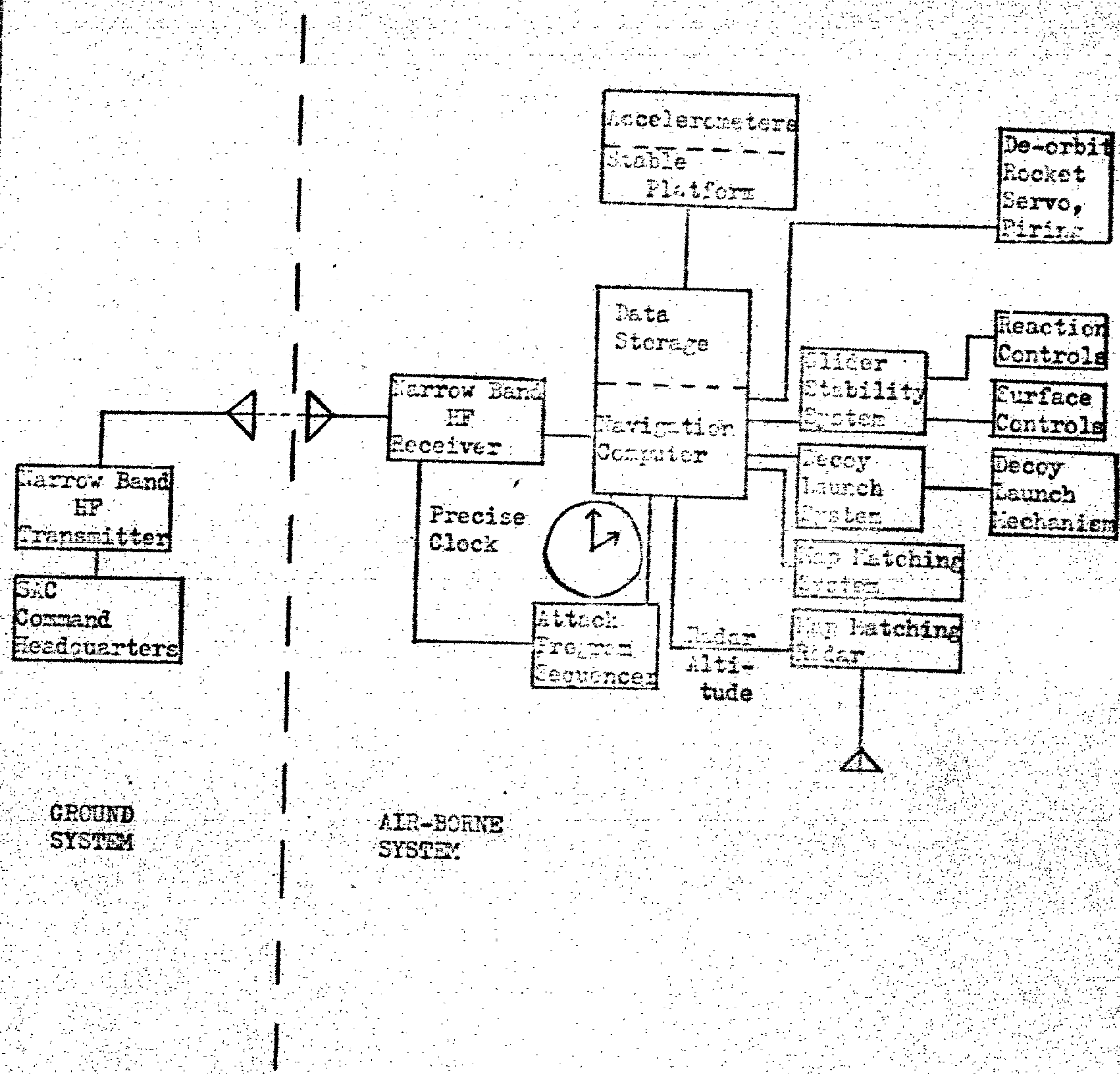


Figure IV.B-8c. Guidance and Control: Attack Phase

earth reaches zero, the de-orbit rocket is fired, the rocket having already been vectored to the specified orientation, and so on.

During re-entry the glide decoys are prepared for launching and released according to plan.

When the check point is approached, the radar map-matching system is activated, a fix taken and the navigation computer corrected accordingly for terminal guidance to the target.

The map-matching radar also supplies altitude correction information for flight control.

(d) Return to Base

Each warhead vehicle is returned to base for maintenance when a malfunction occurs. A Check Out System monitors the guidance, flight control and power supply systems. A failure of any system or back-up system is reported to the beacon responder (see Figure IV B-8b) which transmits the signal to the ground tracking station during the next pass over the United States.

When the ground control station determines that a return to base is to be made, landing instructions are relayed to the vehicle during its next pass over the tracking station. This activates the Return-to-Base Sequencer (See Figure IV B-9a)

which programs the return operation in a manner similar to that for the attack on target.

If failure has occurred in the basic guidance and control systems, control is switched to the auxiliary vehicle systems for return to base.

(e) Warhead Control

Arming and disarming of the warhead is controlled during the various vehicle phases as shown in Figure IV B-9b. Non-nuclear destruct of the vehicle is accomplished as shown, using the narrow band HF command data link.

(3) Guidance Accuracy

Terminal bombing accuracy is determined primarily by the fix-taking operation near the target. This operation was described in section IV.B.2b.

The vehicle must be positioned within a 20 mile square to take this terminal fix. This positioning includes all errors accumulated up to this time.

Tracking accuracy of the ground radar is estimated to be 150 feet in position and 1.5 feet/sec in velocity. Ground computation of satellite position 24 hours after a position fix will be one mile or better by the 1965 time period. Earth shape and lower order perturbations will be predictable to great accuracy by this time.

This means that the vehicle guidance system can accumulate most of the allowable error. Inertial components of the type being used in the DS-I program, monitored by the star tracker during orbital flight, are fully adequate to meet the required accuracy. No major problem is anticipated in designing the airborne computer to meet these requirements.

(4) Decoy Guidance

(a) Orbital Decoys

Orbital decoys to accompany orbital warhead vehicles are launched either with the warhead or separately.

Altitude reference data is obtained from a Horizon Tracker (see Figure IV B-10a) which also determines sun direction for full 3-axis control. Stabilization accuracy requirements are low for the decoy.

A clock, which is reset once a day as the decoy passes over the radar tracking station, controls beacon operation and synchronizes attitude programming.

Radar guidance is proposed for separate boost of decoys into orbit (Figure IV B-10a), using the same type of radar used for satellite tracking.

Dispersal of the decoys is accomplished at the end

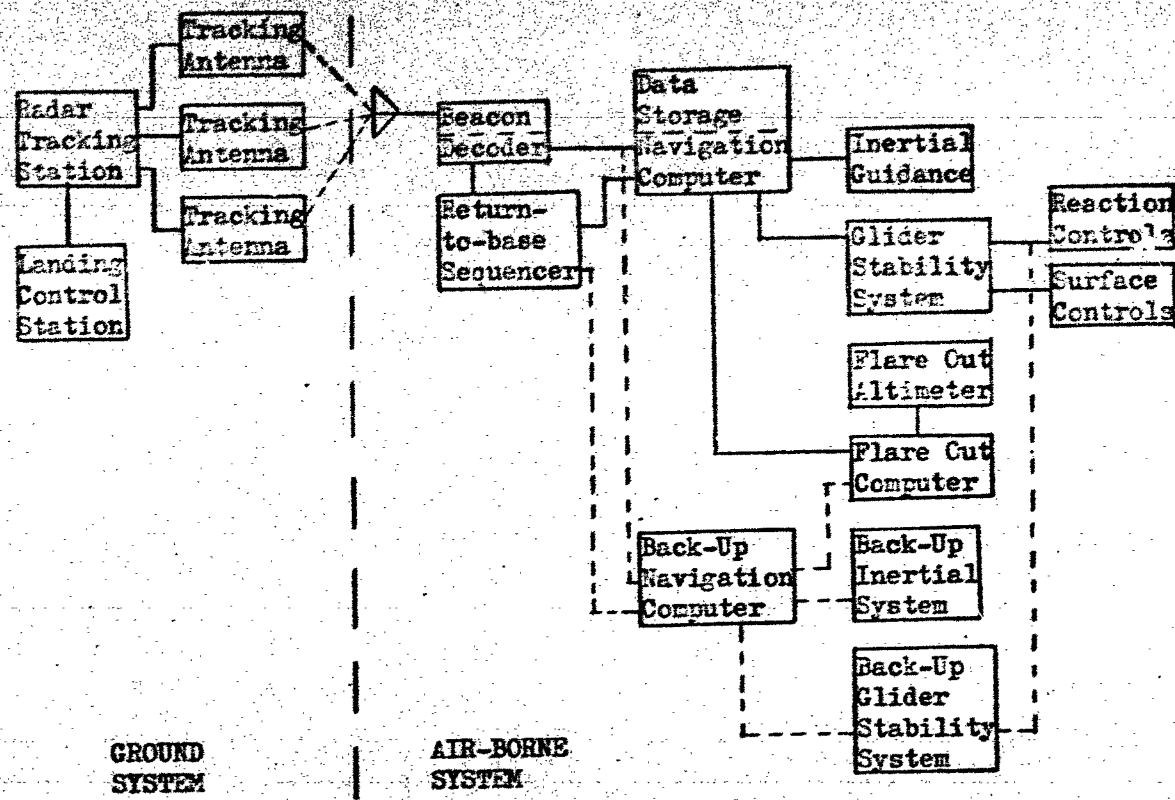


Figure IV.B-9.a. Guidance and Control: Return-to-Base

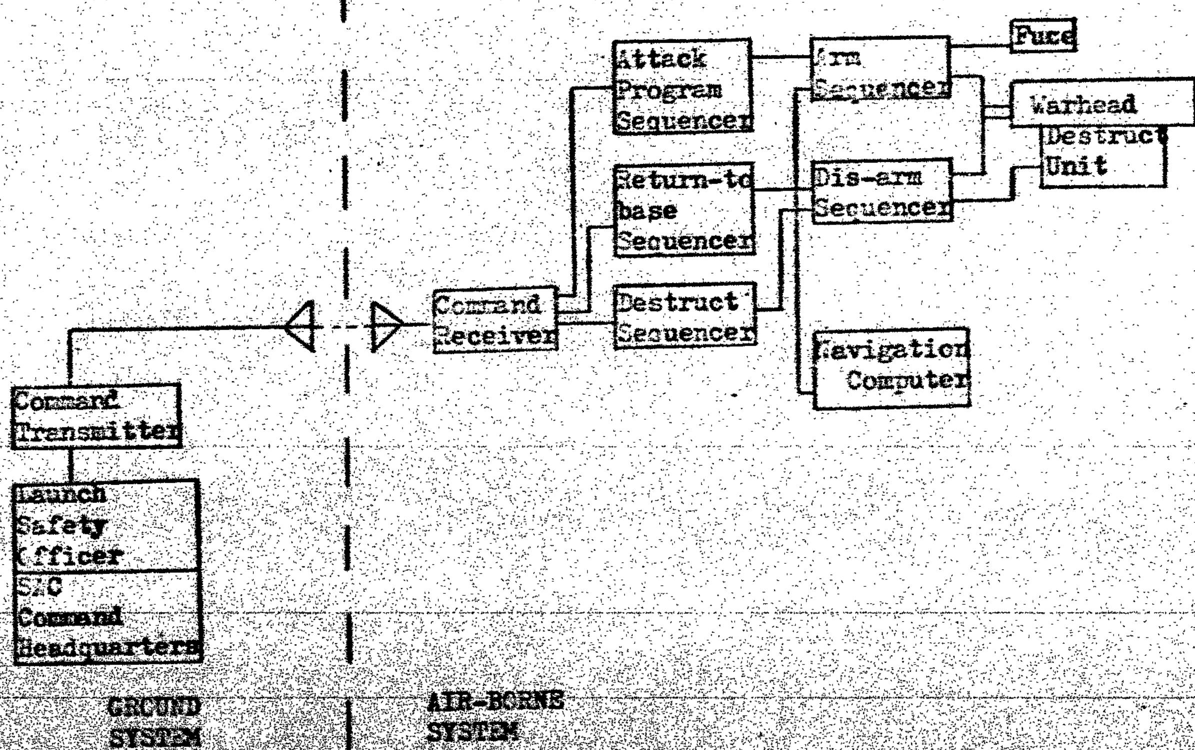


Figure IV.B-9.b. Guidance and Control: Warhead Control

of boost.

(b) Glide Decoys

Glide decoys which are released from the parent vehicle during the attack on target are controlled by a simple 3-axis inertial system as shown in Figure IV B-10b.

d. Miscellaneous Vehicle Subsystems

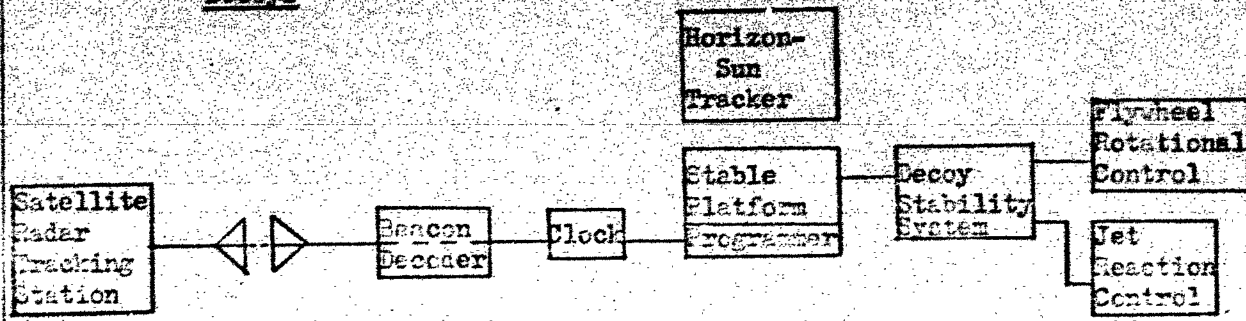
(1) Accessory Power

The one-year flight time and low base load (Fig. IV B-12) make this vehicle a logical application for solar power. A nuclear power plant is heavier and probably less reliable than a solar power plant. Furthermore, the pellet shield requires weight for ballistic reasons, and silicon solar cells are a convenient means for providing this weight.

Neither solar nor nuclear power would be available during re-entry. For the high hydraulic load and long standby time involved a sealed-off hydrazine APU is provided. The insurance of dependable starts after a year of unattended storage is a difficult problem, and the development of critical components should be started as early as possible. An alternate, higher-weight approach is to use a self activating primary battery and a motor-driven hydraulic pump.

Secondary power is also needed during the first few

Decoys



Decoy Launcher

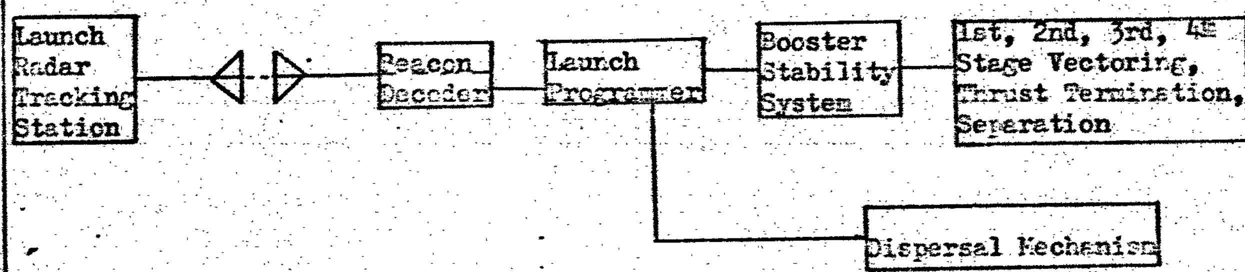


Figure IV.B.10a. Guidance and Control: Orbital Decoys

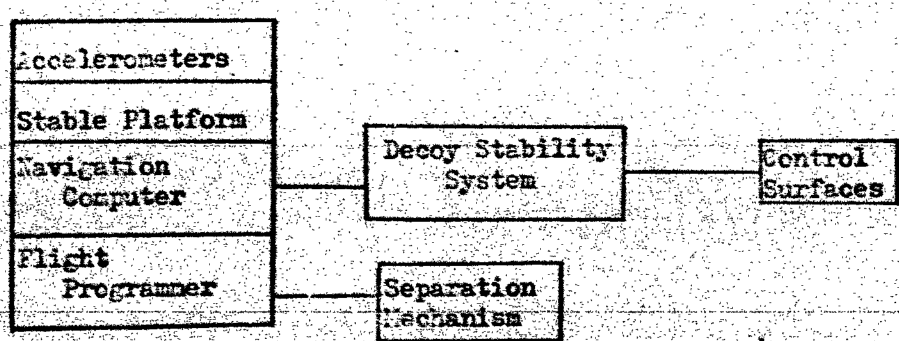


Figure IV.B-10b. Guidance and Control: Glide Decoys

orbits when accelerations from vernier rockets prevent the extension of a solar collector. Early operation of the sealed-off re-entry APU is not desirable. This initial load could best be furnished with silver-oxide zinc primary batteries, which are activated just before launch. The block diagram, Figure IV B-11, shows how the energy sources are interconnected.

The silicon solar cells are mounted on the pellet shield. The solar cells are illuminated during a portion of each orbit, and a sufficiently large area is provided to make the average power generation equal to the average demand. (See Figure IV B-13 for computations) A storage battery is used to provide power when the vehicle is in the earth's shadow or when the collectors are oriented so that power cannot be generated. Inverters are used to supply power for a-c loads. A parallel solar cell system provides emergency guidance power for the return-to-base back-up system.

The APU driven system consists of the APU; an alternator and transformer-rectifier to provide a-c and d-c power to the Pinpoint Guidance and Control System; and a hydraulic system to provide hydraulic power to the flight control actuators.

Initial stabilization at orbital altitude is accomplished with reaction controls which use hydrazine as rocket fuel. Vehicle attitude is then maintained with inertial

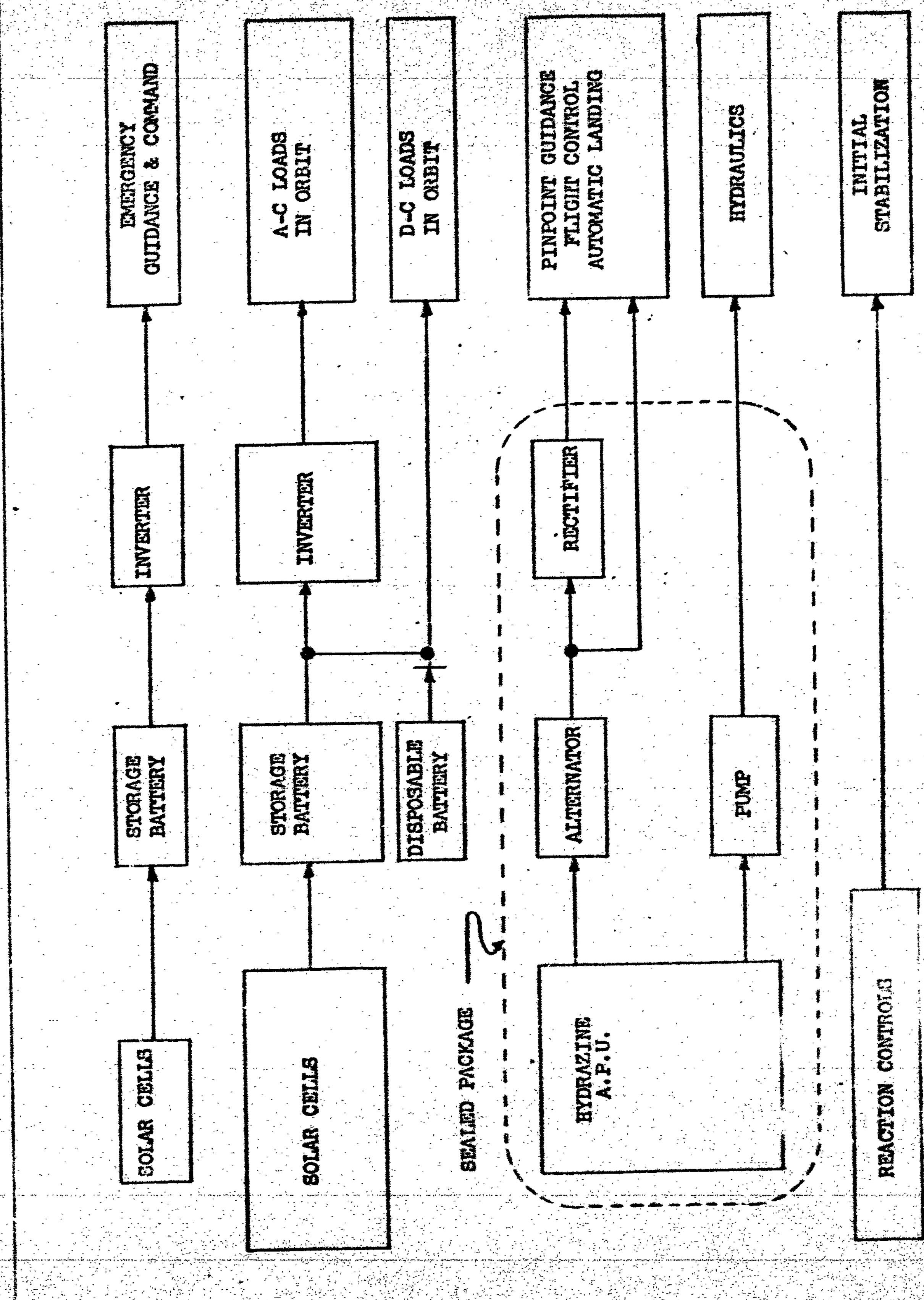


FIG. IVB -11 SECONDARY POWER SUPPLY SYSTEM DIAGRAM

(a) LOAD ANALYSIS	LAUNCH 10 Min	ORBIT 1 Year	DIVE INTO TARGET 2 Min	BASE COMMUNICATION 5 Min	LANDING 60 Min
RADIO GUIDANCE	65				
STAR TRACKER COMPUTER	850	240	850	240	850
FLY WHEEL DRIVE		20	20	20	
COMMUNICATIONS				100	
COOLING	90	90	90	90	90
PRIMARY SOLAR SYSTEM	1005	350	960	450	910
EMERGENCY GUIDANCE BACKUP SOLAR SYSTEM	160	160	160	160	160
PINPOINT GUIDANCE			AC / DC		
RADAR			600 / 400		
MAP-MATCHER			400 / 200		
FLIGHT CONTROL			310		310
LANDING BEACON					65
COOLING			750		750
ELECTRIC POWER GENERATOR DRIVE INPUT			2260W 4.5H.P.		1125W 1.9H.P.
HYDRAULIC PEAK			17.3H.P		17.3H.P.
HYDRAULIC AVERAGE					5.5H.P.
APU PEAK			21.8H.P.		19.2H.P.
APU AVERAGE					7.4H.P.

(b) SOLAR SYSTEM WEIGHT ESTIMATE	POWER RATING WATTS	COLLECTOR AREA SQ.FT.	SYSTEM WEIGHT LBS.
PRIMARY SOLAR SYSTEM	350	190	260
BACKUP SOLAR SYSTEM	160	85	117
COMBINED SOLAR SYSTEM	510	275	377

FIG. IVB -12 LOAD ANALYSIS AND SYSTEM WEIGHT ESTIMATE

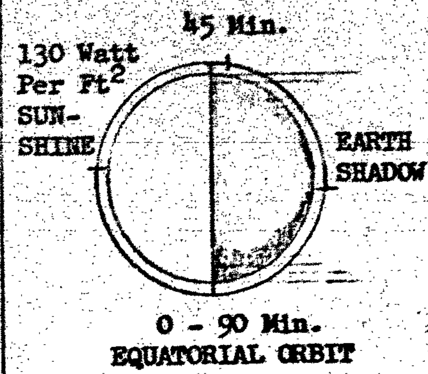
controls until de-orbit, at which time reaction controls are again used.

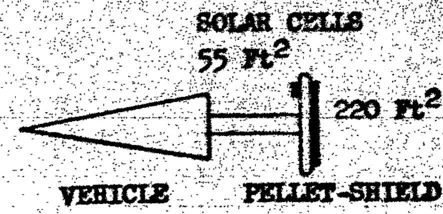
(2) Environmental Control

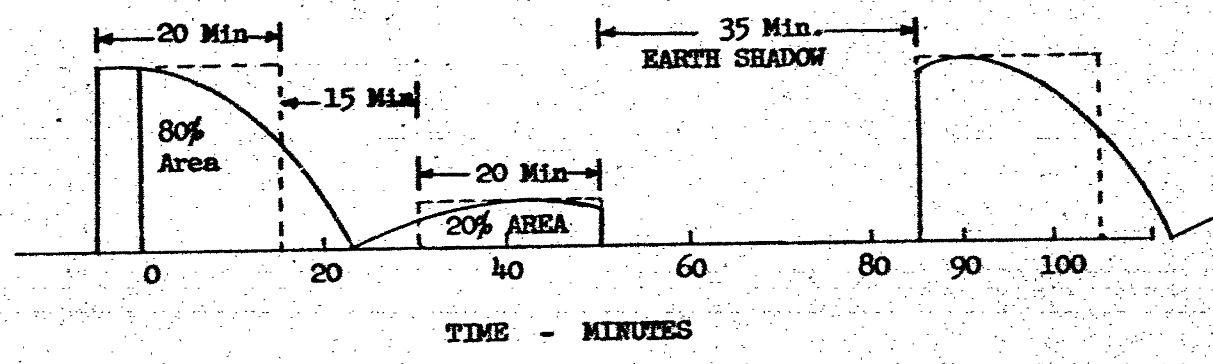
Two (2) separate cooling systems are used. One system is for launch and re-entry and utilizes an expendable heat sink. The other system is for orbit and utilizes skin surface radiation to space. The pressurization system utilizes Freon gas to absorb heat from equipment and to release heat to heat exchangers or radiators. A small amount of Freon is stored to replace any gas that might diffuse through the skin. The compartment is sealed. Redundant, two-speed blowers are used, either of which is capable of circulating all of the heat transport medium (Freon gas).

During launch and re-entry, Freon is circulated through the heat producing equipment. The flow valve allows the Freon gas to be moved through a water to Freon heat exchanger and then through an ammonia to Freon heat exchanger. The Freon gas is then returned to the heat producing equipment. During launch, ammonia probably will not be injected into the ammonia - Freon heat exchanger, as the chilled water heat exchanger may cool the heat transport medium adequately.

At some predetermined altitude and temperature range, the flow valve diverts the heat transport medium to the skin radiator and shuts off heat exchanger vents and water supply to the heat exchanger. The blower







510 WATT CONTINUOUS POWER REQUIREMENT IN ORBIT

10% Silicon Solar Cell Efficiency

95% Diode Efficiency for Paralleling Silicon Cells

80% Storage Battery Efficiency

90% D-C to A-C Inverter Efficiency

85% Density of Solar Cells on Solar Collector Assembly

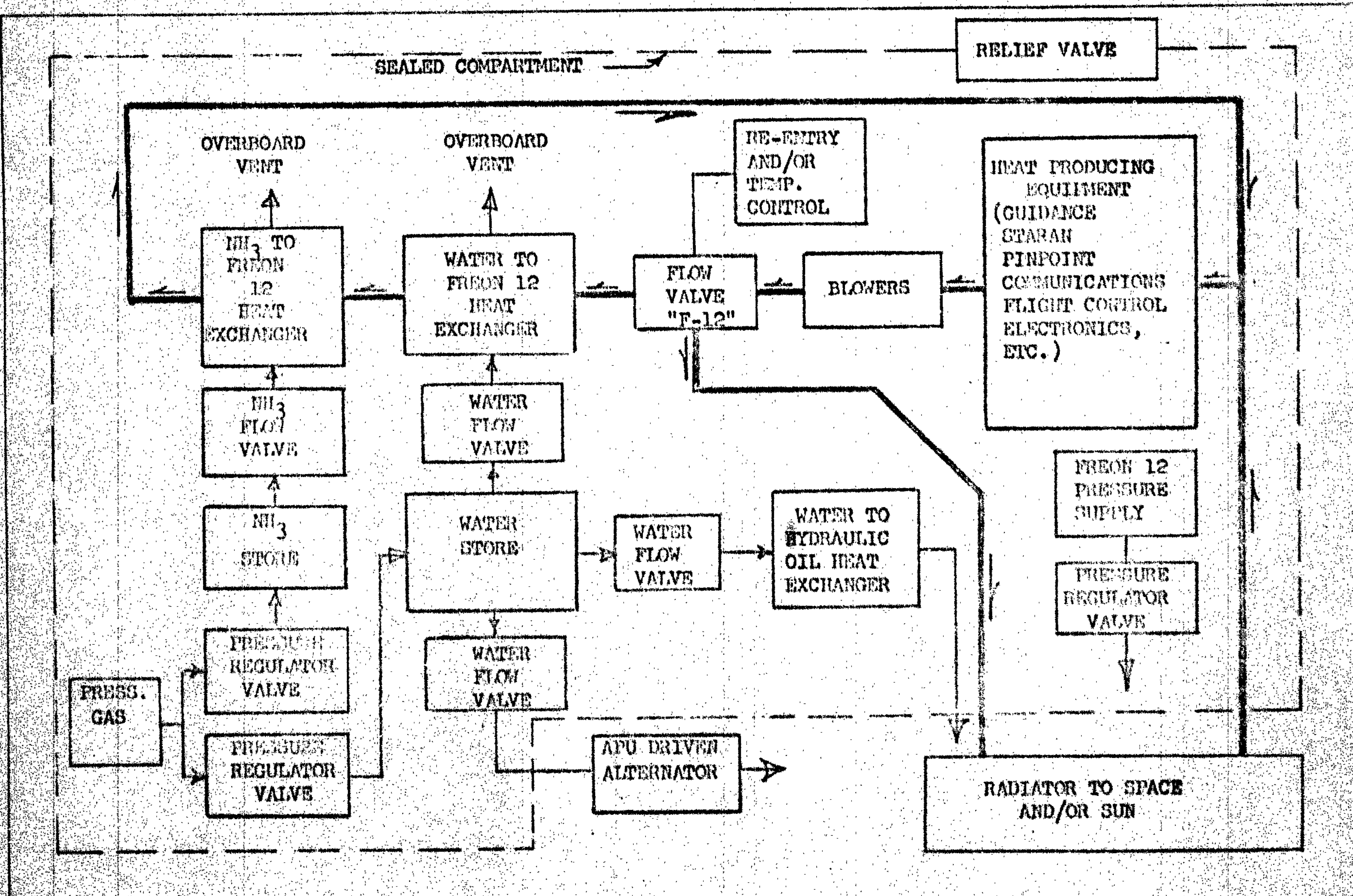
80% of Cells Located on Face of Pellet-Shield
20% of Cells Located on Vehicle Face of Shield

275 Sq. Ft. of Solar Collector at 1 lb/Sq.Ft	275 lbs.
570 Watt nickel-cadmium Storage Battery	62
3 kw Diodes, Wiring, etc.	30
510 Watt Inverter	10
Combined Solar System Weight	377 lbs.

3 ORBITS WITHOUT SOLAR POWER IN THE POST LAUNCH PERIOD:

2.3 kw Hr. of Silver-Zinc Single-Use Battery 50 lbs.

FIG. IVB-13 SOLAR POWER SUPPLY



EQUIPMENT COOLING AND PRESSURIZATION SYSTEM

FIGURE IV.B-14.

circulates the Freon gas through the radiator to the heat producing equipment. The Freon gas temperature out of the radiator will not exceed 75 - 85°F even if the radiator faces the sun. When the radiator is not facing the sun, the outlet Freon temperature may be approximately -5°F. A by-pass and mixing valve may then be required to maintain proper limits of the equipment cooling.

Upon re-entry, the flow control valve again passes the Freon through the water and ammonia heat exchangers. Ammonia is admitted for adequate cooling at altitudes below approximately 75,000 feet.

A study will be made of the heat sink capabilities of the equipment and bomb to determine if the ammonia system is necessary. The main concern is the effect of high temperature on the high explosive charge in the warhead.

(3) Communications

A long-range, secure world-wide communication system is used to transmit the "attack" command to all vehicles. Discrete addresses are used with each transmission. This system has an extremely low false-alarm rate. The same receiver is used to receive a destruct message.

The receiver has a 50 - 100 cps information bandwidth and operates with programmed frequency changes in the

HF band. A first order correction of the Doppler shift is controlled by the vehicle navigation system. It is coded for anti-jam, anti-false command. False alarm rate is once every 1,000 years.

3. Ground Systems and Support

a. Introduction

Ground system planning for this weapon system is based upon the vehicle as described in the previous section and the following preliminary operational requirements:

Utilization: Approximately 500 glide bombs are in orbit at all times under "steady state" conditions. Mission duration is one year.

Launch Rate: Average of 1½ vehicles per day for an indefinite period.

Reaction Time: Time of firing will be announced at least one day before launch.

Base Locations: 25° to 35° N. latitude; eastward firing is required.

Vulnerability Allowable: No protection is required against enemy missile or bomber attack.

Recycle Time: One week for glide bombs and recoverable first stage boosters.

Vehicle Life: Glide bombs 30 flights; recoverable first stage boosters 250 flights.

Since the postulated launch rate will establish the 500 warheads in orbit in slightly under one year, this figure can be used for the required overhaul rate for glide bombs and first stage boosters as well. No allowance is made for losses, failures or aborts in this approach, but the resulting ground system can be scaled up to compensate for reasonable failure rates when

investigation has progressed to the point where these rates can be established.

On this basis, a single base, manned and equipped to launch and recover all vehicles, is postulated. Eleven recoverable first stage boosters are required in service at all times. Two or three units per year will be replaced due to wearout, but this will not reduce the first stage maintenance and overhaul requirements enough to affect planning for these operations.

New vehicles are delivered to the base in the largest sections practicable, taking size and safety into account. First and second stage boosters can be delivered as complete units; glide bombs must be shipped in several sections. In all cases, new vehicle assembly will utilize stations on the production lines set up for maintenance, overhaul and testing of recovered units.

The general concept for accomplishing maintenance coincides with that described for the ICBM in Section III.A.3. Any differences between the two programs will be concerned with degree or details of accomplishment, rather than changes in basic principles.

b. Sequence of Operations (Figure IV.B.15)

New first stage boosters are flown to the launch bases. They are serviced, checked out, and reworked if necessary, in the same manner as recovered boosters. A production line arrangement is envisioned for first stage overhaul, maintenance and testing.

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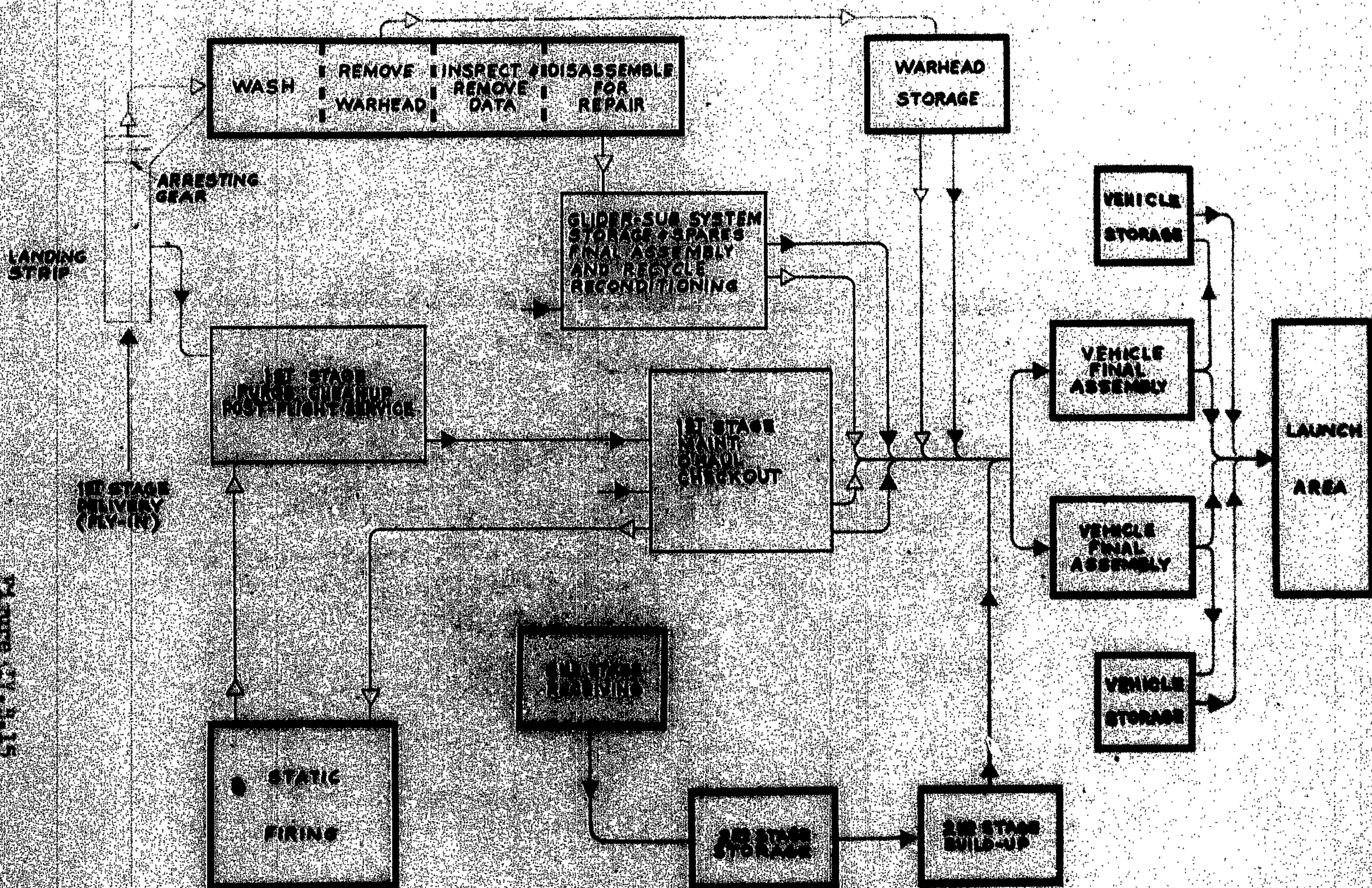
IV B SEQUENCE OF EVENTS



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SEQUENCE OF EVENTS IV B

Figure IV.B.15

Second stage boosters are received in a fully assembled condition. Only checkouts and a small amount of repairs for damage in transit or handling should be necessary on this item since a new second stage is required for each launching.

Glider airframes are shipped in three large sections — fuselage and wings. Retro rockets, warheads and other hazardous items are shipped separately. Production line-type maintenance, overhaul, build-up and test operations are required.

The three built-up sections of the vehicle are joined at a final assembly station. A strongback which later serves as a transportation dolly, storage fixture and erection beam permits final assembly in the horizontal position. At this point the assembled missile is subjected to a complete functional check of all systems practicable, and upon successful conclusion, is transported on its strongback to the launch site. The strongback is connected to trunnions on the launch platform and erection mechanism. Vehicle-to-launch platform connections are secured, monitor and servicing lines attached, and the guidance system aligned. After a confidence check, fueling and final servicing are performed. The pilot enters the first stage booster cockpit a few minutes before launch and takes part in the terminal phases of the countdown. The strongback and umbilical are released from the missile just prior to first stage ignition;

lowering occurs during and after the launch sequence. The strongback is returned to the base industrial area for cleanup and reuse afterwards.

During the launch operation, which is sequenced and monitored by the control center, confidence checks are made on critical vehicle sub-systems, and all communication and military equipment sub-systems.

After completing its launch mission, the returning booster approaches the landing strip and completes touchdown. As forward motion ceases, a standard aircraft towing vehicle is connected to the nose wheel of the booster, and the booster is towed to the Purging Area and from there to the booster assembly area for inspection and repair if necessary. Static test firing on used boosters will be accomplished only after major repairs have been performed or vital components have been replaced.

Returning glide bombs are guided down to the landing strip by the automatic landing system. Arresting gear is provided at each end of the runway for emergency use. As forward motion ceases, a self-propelled dolly designed to achieve rapid, mechanical loading retrieves the glide bomb, and moves it to the automatic wash down area, where it is cleaned preparatory to further processing. It is then taken to the warhead removal area, where unexpended explosives are quickly examined for arming safety, removed, inspected, and distributed to the salvage

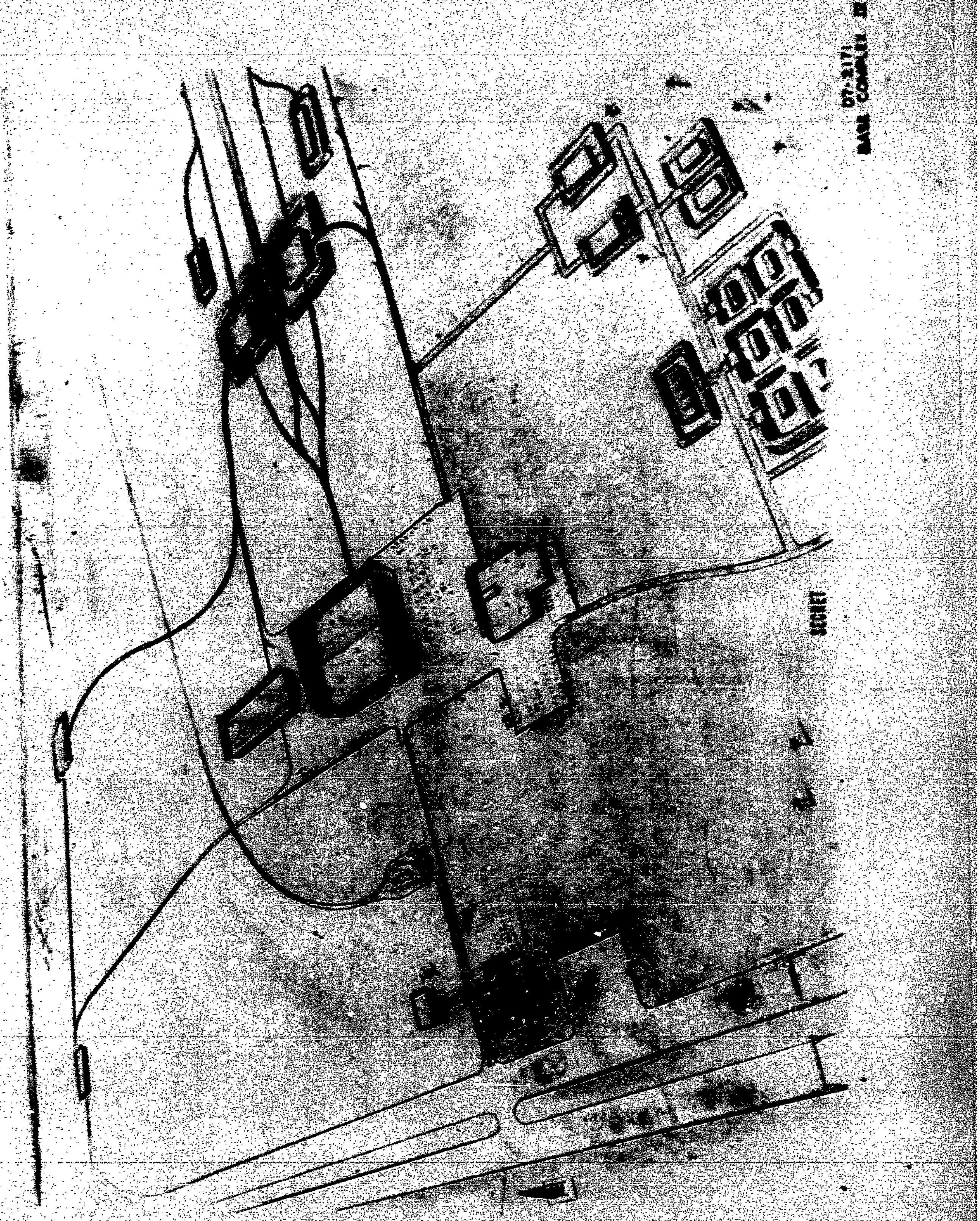
area.

The major steps in this sequence are summarized in Figure

c. Base Complex

The operational base for the Orbital Bomb system is located at Eglin Air Force Base, Florida, so that launchings may be made eastward into approximately 30 degree equatorial orbits. Figure IV.B.16 illustrates a representative complex for this base.

Two or more 8,000 - 10,000 foot runways are provided for recovering both the glide bomb and the first-stage booster. Wash-down facilities near the runway are used for decontamination of the glider and a purging area is provided for defueling the liquid booster. The non-hazardous area of the base contains an administrative building, and glider airframe and first-stage booster assembly and maintenance buildings. Hazardous operations are separated from the rest of the base by revetments and distances in accordance with applicable safety regulations for the various materials being stored and handled. Facilities for the inspection, storage, and mechanism installation of retro rockets, warheads, etc., are provided in such a way that the quantities of hazardous materials in any one location are kept at a minimum. Redundant buildings are provided so that an accident will not halt production. Cryogenics are produced in the vicinity of the launch complex and transferred to the point-of-use and local



BASE COMPLEX
Figure IV.B.16

storage facilities as needed.

Final assembly and checkout of the completed vehicle are accomplished in redundant, separated buildings. From these buildings rail systems for transporting the vehicle extend to each of the launch sites. Each of the sites consists of a pad with a dry-type blast deflector, vehicle erection mechanism, and shelters for fixed vehicle servicing equipment, as well as launch monitor and control equipment.

Static firing in the vertical position may be required after first stage booster major overhaul. If so, a static firing stand with wet-type blast deflector will be provided in the launch area. A separate control building would be required for this installation. (Figure IV.B.17)

d. Ground Cooperational Equipment

This category of equipment includes those items and facilities directly involved in and required during missile launch and recovery operations. For the Orbital Bomb, major items of this nature include launch platforms, arresting gear and autocollimators. Provisions for pilot access to the first stage booster, and monitor and servicing lines, are incorporated in the vehicle strongback.

Two independent electrical launch equipment systems are provided, each having the capability of initiating, monitoring, and sequencing the complete launch operation for any vehicle assigned to the station. Automatic sequencing allows the launch operation

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STATIC FIRING
Figure IV.B.17

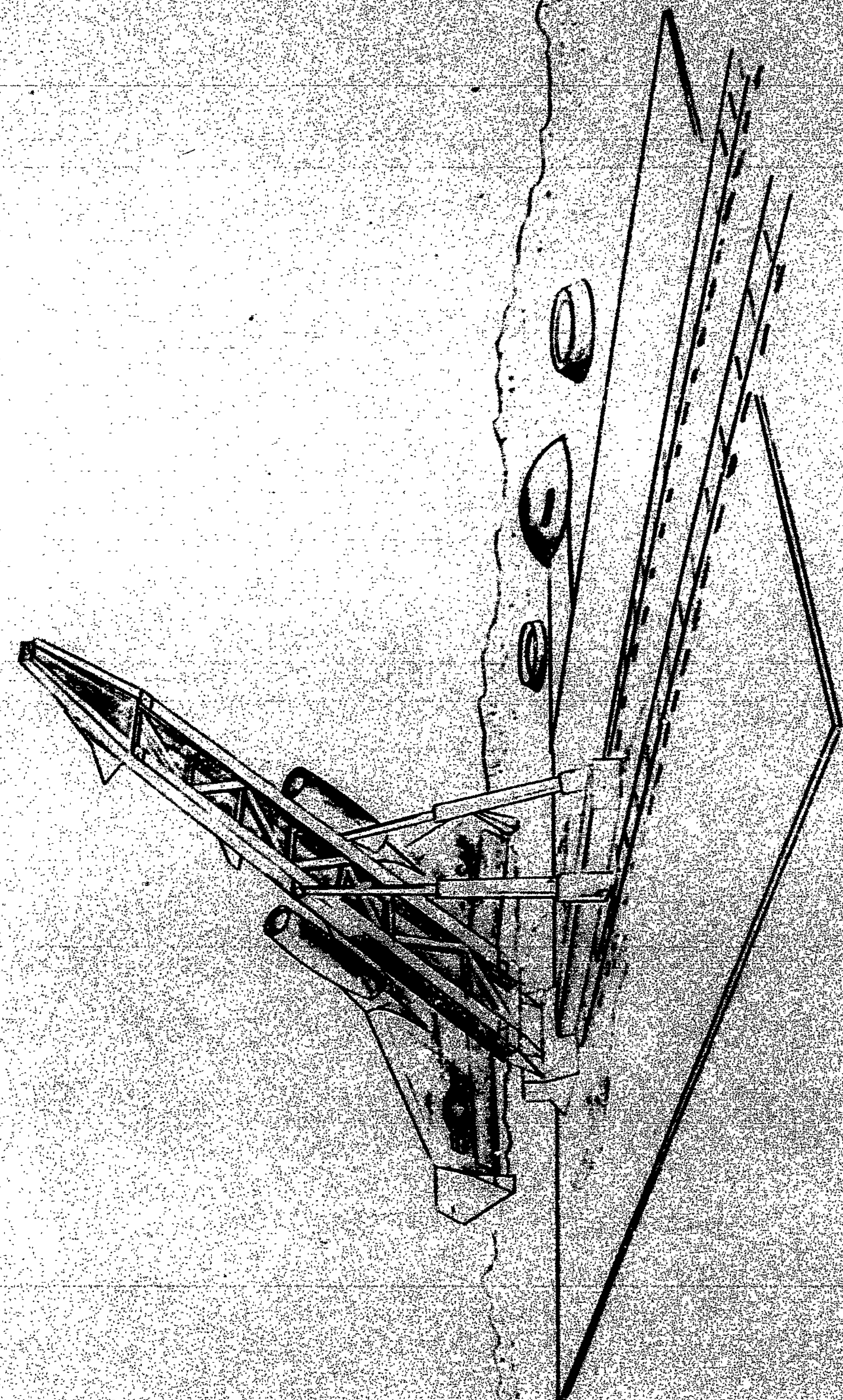
to proceed to completion when all systems checks are within acceptable tolerances. Malfunction causes stoppage of the automatic sequence, and indicator lights identify the faulty vehicle subsystem or launch equipment involved. Each console is manned by an operator who maintains surveillance over the progress of the launch sequence. (Figure IV.B.18)

The launch control officer selects one of the two consoles to perform the operational countdown for each firing. Duplicate displays and closed circuit television communication with the launch site keep him informed of the progress of the countdown. The control officer has the capability of transferring the launch sequence to the second console in the event that sequence stoppage occurs as the result of system failure in the active console.

e. Ground Support Equipment

Items of support equipment required after factory completion of components, but not directly associated with the operational firing of the weapon, fall into this category. For the Orbital Bomb, items similar to those listed in Section IV.A.3.e. are required.

Functional checkout sets are provided in the base overhaul and assembly facility at stations where tests and acceptance inspections are required on the various missile sections. Functional checkout performed at any level of assembly will confirm but not duplicate the test at the preceding lower level.



LAUNCH PAD
Figure IV.3.18

Test tolerance requirements will be based on the tolerance required for final missile acceptance, with each successively lower level of test requiring tighter tolerance to insure that the final acceptance tolerance can be met.

The functional test system will be centrally located in the facility with each test station providing the correct connector to the missile section and with controls for the operator to select the proper test and observe the result. The system will utilize digital computer techniques, proven modular components, automatic programming, self-checking and fault isolation circuitry. Consideration will be given to:

- Use by personnel with limited skills.
- Changes in missile design and/or test requirements.
- Accumulation of statistical data for the reliability program.
- Tolerance matching of missile equipment for improved performance and reliability.
- Glider life and equipment failure prediction.
- Stock and inventory control.

This functional checkout system will be compatible with the overall manufacturing, reliability and maintenance programs.

Following complete assembly of the missile in the final assembly building, an integrated missile systems functional test is performed. The checkout equipment provided isolates faults to a missile section.

f. Spares and Supply

As indicated in Part III.A.3.b.(6), the Boeing Spares and Supply concept described therein is equally applicable to the Orbital Bomb. Differences would be only a matter of detailed requirements in distribution flow, quantities, rate of operation, etc. A comprehensive formal plan worked out to the necessary detail will be defined, once the firm requirement for such an operational weapon system has been established.

g. Personnel Support

Personnel Support for the Orbital Bomb System divides itself into two categories: operation and maintenance personnel for the ground-vehicle data link, and operation and maintenance personnel for the assembly-through-launch-and-recovery sequence. Each category imposes organizational and quality criteria which are satisfied by skill alignment and grouping, and by the exacting integration of system requirements and individual personnel abilities. A training system within the potential of the military training base provisions the skills and proficiencies which the weapon system requires for successful operation. On-the-job training serves primarily to integrate the individual into the operation and maintenance team.

Personnel Recapitulation

Flight Personnel	10
Direct operation and maintenance:	3000-4000

4. Force Size

Figure IV B-19 illustrates the method by which force size is defined. The initial weapon system force (M_F) required to obtain a specific number of targets killed is obtained by working backwards from the target complex.

The following sections show how the initial force required to kill 80% of a postulated target complex is determined.

a. Target Complex (T_C)

The target complex is a function of (T_M) the number of targets, (H_T) the target hardness, and (D_T) the target dispersion. (T_M) and (D_T) are defined as 300 targets equally distributed throughout the U.S.S.R., satellite, and Arab lands. This target distribution is illustrated in figure IV B-20. The target hardness (H_T), is defined as 50 targets that require 200 psi, 200 targets that require 50 psi and 50 targets that require 10 psi to kill them.

The orbital glide bomb under consideration carries a 0.5 MT warhead and has a C.E.P. of 1350 feet. Figure IV B-21 illustrates the capabilities of such a system against the assumed target complex. The bomb has a probability of .84 of destroying the 200 psi targets, .99 of destroying the 50 psi targets, and 1.0 of destroying the 10 psi targets.

To achieve the system objective, i.e., destroy 80% of each of the three types of targets, 47 bombs must reach the 200 psi targets, 161 bombs must reach the 50 psi targets, and 40 bombs must reach the 10 psi targets. Thus, a total of 248 bombs are required at M_M to achieve the required target kill.

DEFINITION OF FORCE SIZE

ORBITAL BOMB WEAPON SYSTEM

$M_F = f \begin{cases} V_S = \text{SPACE VULNERABILITY} \\ OPI = \text{OPS. PERFORM INDEX} \\ V_A = \text{AIR VULNERABILITY} \\ TC = \text{TARGET COMPLEX} \end{cases}$

$V_S = f \begin{cases} D_S = \text{ENEMY SPACE DEFENSE} \\ C_S = \text{SPACE COUNTER MEASURES} \end{cases}$

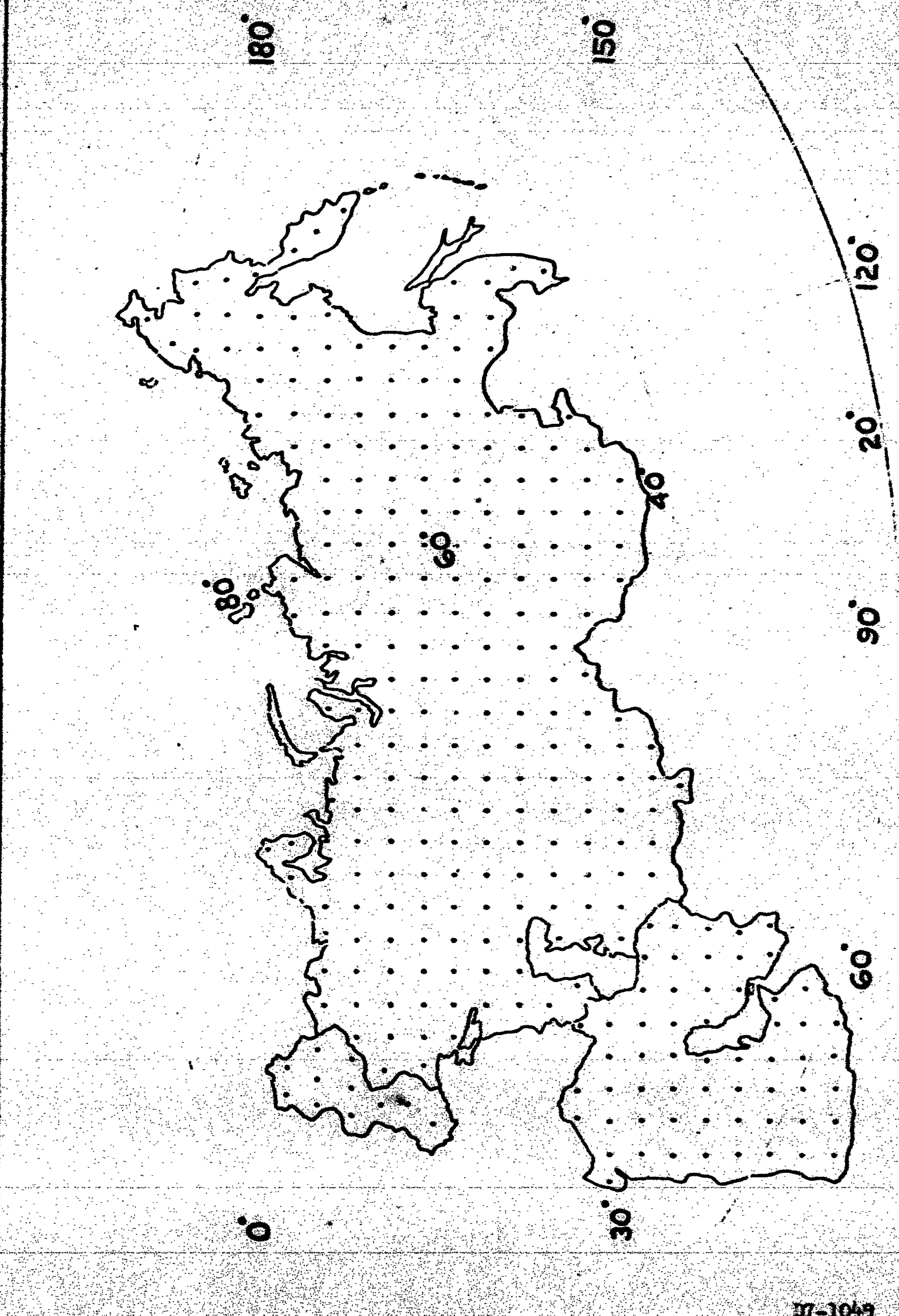
$T_C = f \begin{cases} T_M = \text{MILITARY TARGETS} \\ H_T = \text{TARGET HARDNESS} \\ D_T = \text{TARGET DISPERSION} \end{cases}$

$OPI = f \begin{cases} R_E = \text{EQUIP. RELIABILITY} \\ F_{IC} = \text{FORCE IN COMM.} \\ H_F = \text{HUMAN FACTORS} \\ S_A = \text{SYSTEM ACCURACY} \end{cases}$

$V_A = f \begin{cases} D_A = \text{ENEMY AIR DEFENSE} \\ M_D = \text{VEHICLES ENTERING DEFENSE} \\ D_E = \text{FRACTION OF DEFENSE ENCOUNTERED} \\ C_A = \text{AIR COUNTERMEASURES} \end{cases}$

Figure IV B-19

159c
Rev. 6-23-59
Rev. 12-8-58



ASSUMED TARGET DISTRIBUTION
300 TARGETS

FIGURE IV.B-20

D7-1049

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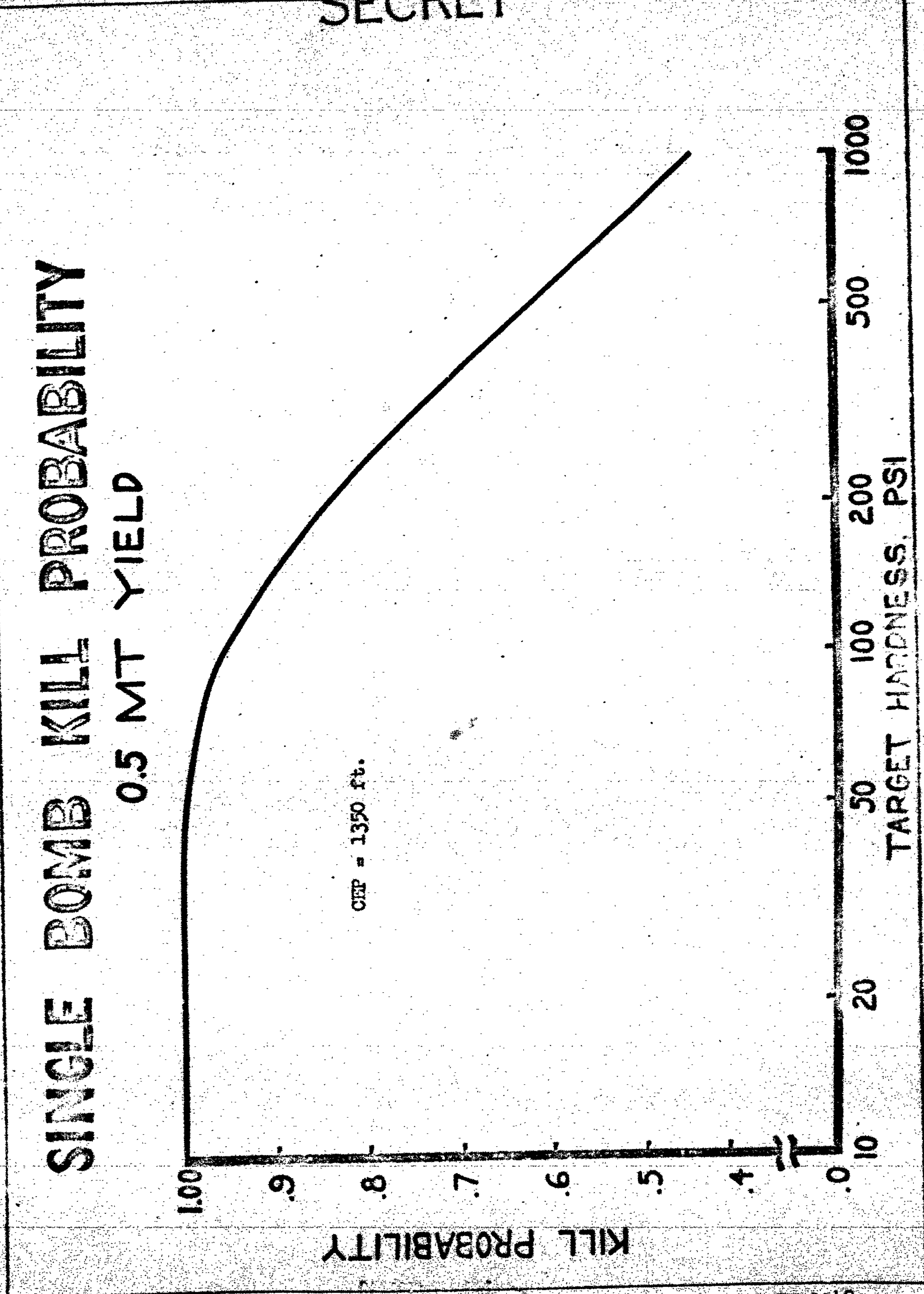

SINGLE BOMB KILL PROBABILITY
0.5 MT YIELD
CEP = 1350 ft.
KILL PROBABILITY
1.00
.9
.8
.7
.6
.5
.4
0
10
20
50
100
200
500
1000
TARGET HARDNESS, PSI

Fig. IV B - 21

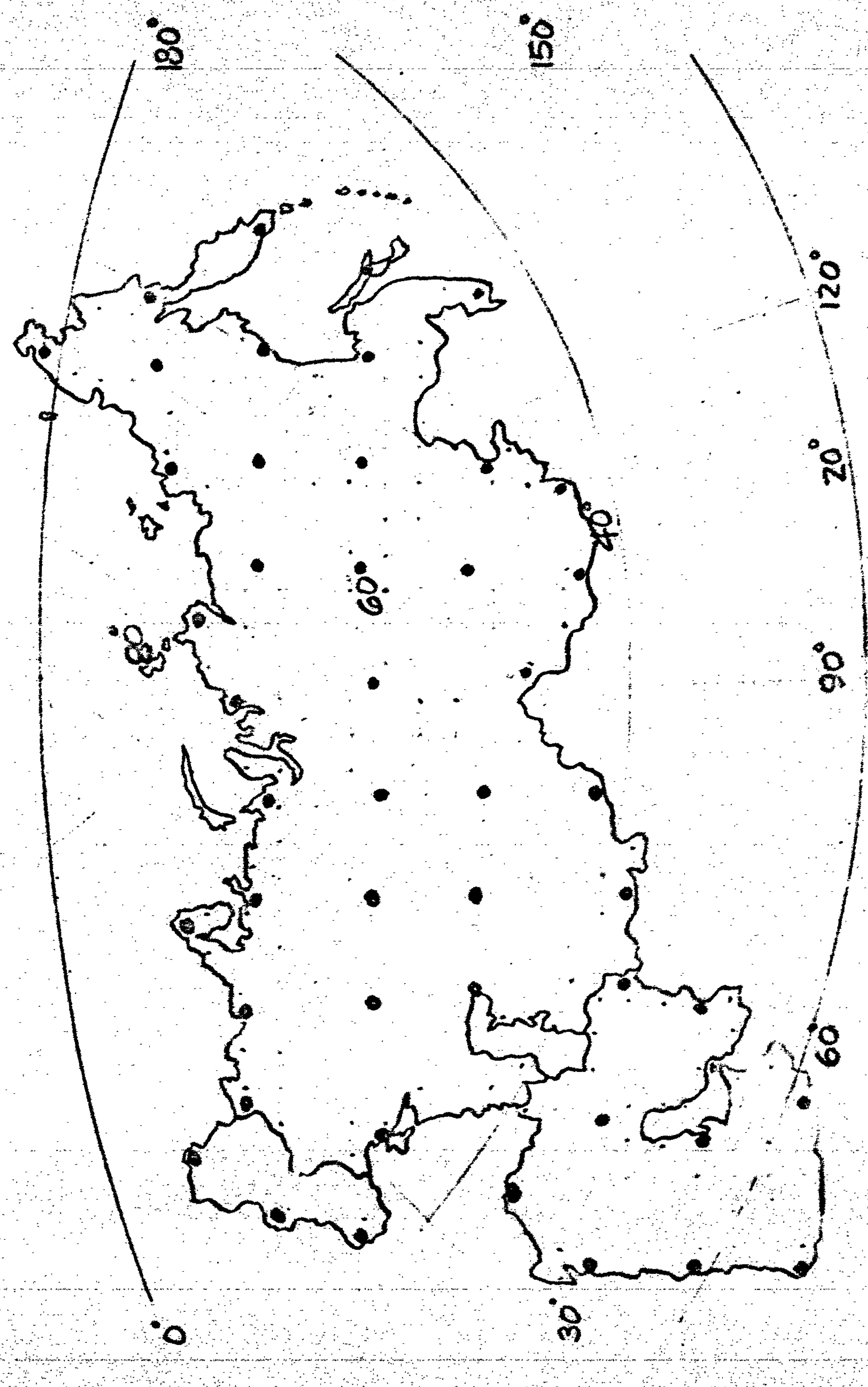
b. Air Vulnerability of Weapon System (V_a)

The air vulnerability is a function of (D_a) the enemy air defense, (M_D) the number of vehicles that enter the defense, (D_e) the fraction of the defense encountered and (C_a) the air countermeasures employed by the offense.

The enemy air defense (D_a) is assumed to be located as illustrated in the figure IV B-22. Each dot represents a base with 50 air defense and 50 space defense missiles (see section II of this report). The defense has sufficient radar tracking and missile range capability to allow all of the 48 sites, (D_e), to expend their full load of 2400 missiles at the incoming force.

Each incoming orbital glide bomb has 5 decoys, (C_a), which it releases as it enters the defense. The total force of missiles and decoys can enter the defense in about 143 minutes as illustrated in figure IV B-23. The method of target assignment for the orbiting bomb described in Paragraph IV B 2 c will achieve corridor and point defense saturation against short range defense missiles but probably not against long range defense missiles. Saturation effects have been neglected in this analysis.

The number of vehicles, both bombs and decoys, (M_D) that enter the defense is a primary factor in determining the air vulnerability of the system (V_a). Figure IV B-24 shows the vulnerability to the assumed enemy air defense. The curve shows that in order to have 248 bombs reach targets, (M_M), 528 bombs must enter the defense (M_D). The postulated defense is missile limited if the number of bombs entering is over 400.



ASSUMED ENEMY DEFENSE SYSTEM

5° SPACE AND AIR INTERCEPTORS AT EACH SITE

Figure IV.B.22

DURATION OF ATTACK

ORBITAL GLIDE BOMBS IN 35° ORBITS UNIFORMLY DISTRIBUTED AROUND THE WORLD

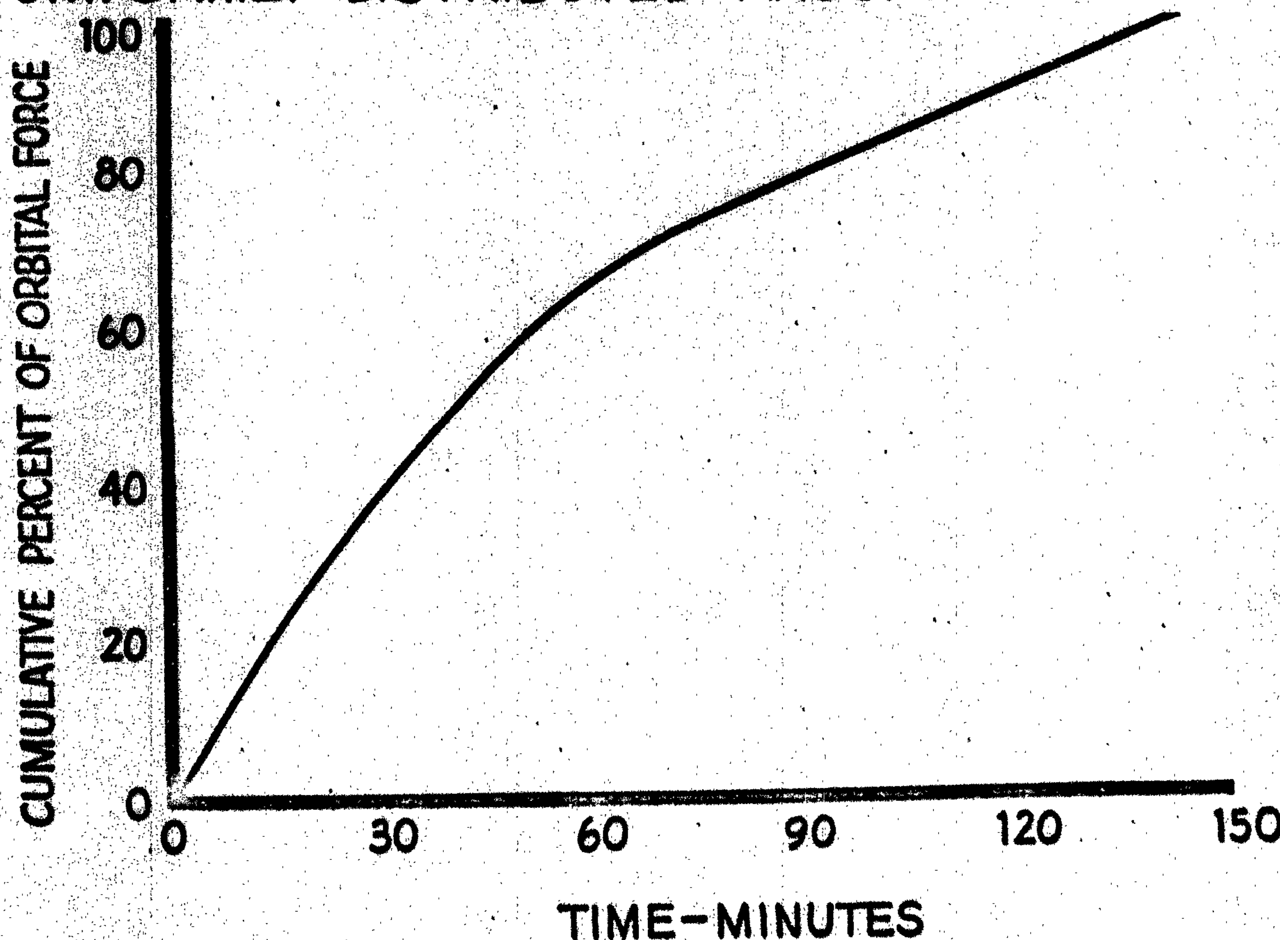


Figure IV B-23

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VULNERABILITY TO AIR DEFENSE

5 DECOYS / GLIDE BOMB
2400 AIR DEFENSE MISSILES

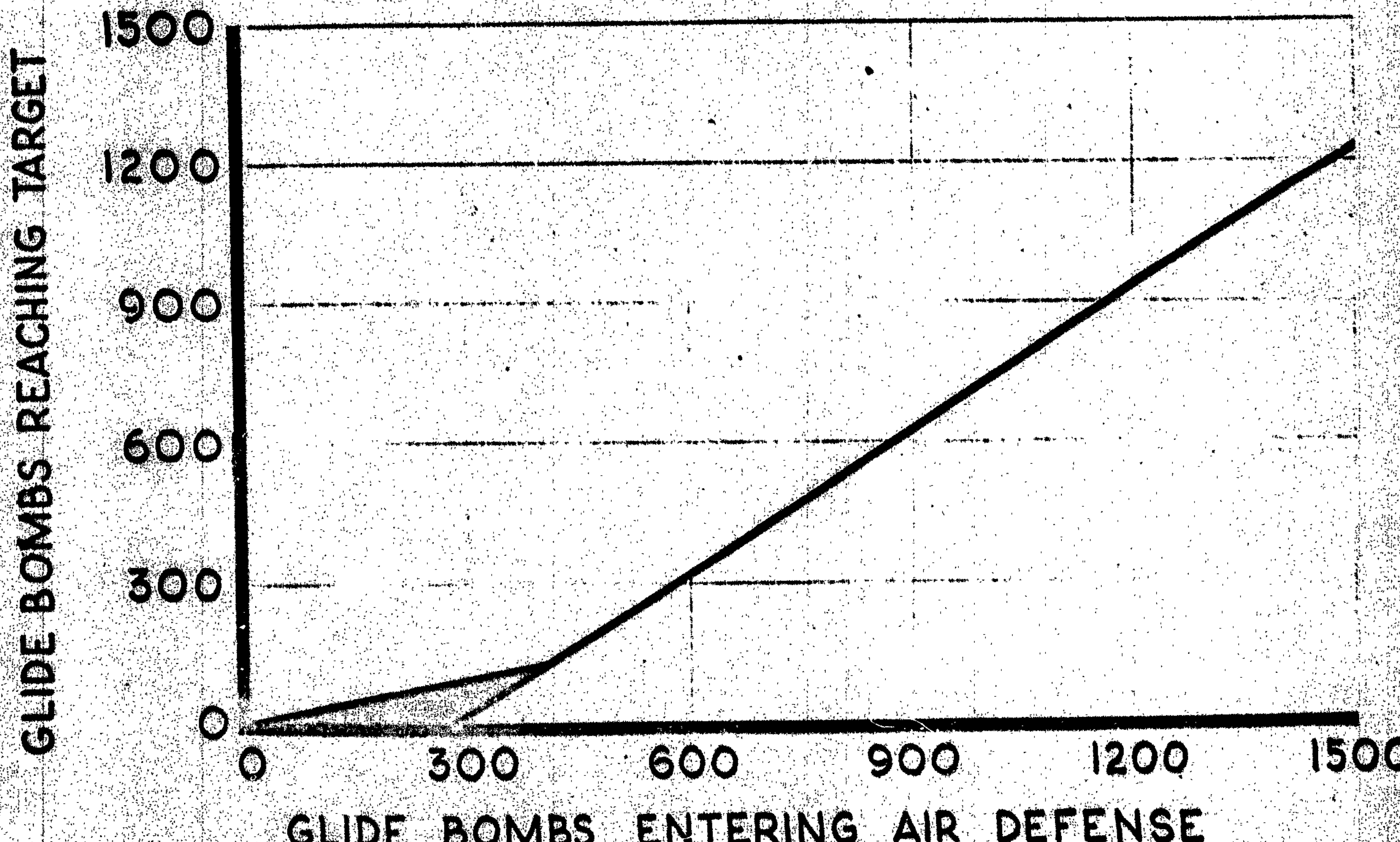

Figure IV B-24

165c

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c. Weapon System Operational Performance Index (OPI)

The operational performance index is a function of (R_e) equipment reliability, (F_{IC}) force in commission, (H_f) human factors and (S_a) system accuracy. Human factors (H_f) and force in commission (F_{IC}) do not apply to this analysis. The system accuracy (S_a) is included in the target complex considerations. The only factor that applies to this section is equipment reliability (R_e) which is assumed to be 0.7. Thus, to have 528 vehicles at (M_D) there must be 754 vehicles at (M_P).

d. Space Vulnerability of Weapon System (V_S)

The space vulnerability is a function of enemy space defense (D_S) and space countermeasures (C_S).

The enemy space defense is defined in Section II of this report. The enemy has the capability in a surprise attack to fire on about 1/6 of the orbiting force before the weapon system can react. This, coupled with a defense kill probability of 0.7 means that 754/(1-0.7/6) or 857 total vehicles are required. With 5 decoys/orbiting bomb (C_S) the defense must expend 883 defense missiles to achieve the above result. Twenty of the 48 defense missile sites can reach the bombs in orbit, thus 1000 space defense missiles are avialable for this attack.

e. Force Size (M_F)

Force size is a function of all the factors previously considered. It has been determined in the previous paragraphs that a force of at least 857 orbital missiles will be required to kill an average of .80% of the targets. Figure IV B-25 is a summation of these factors.

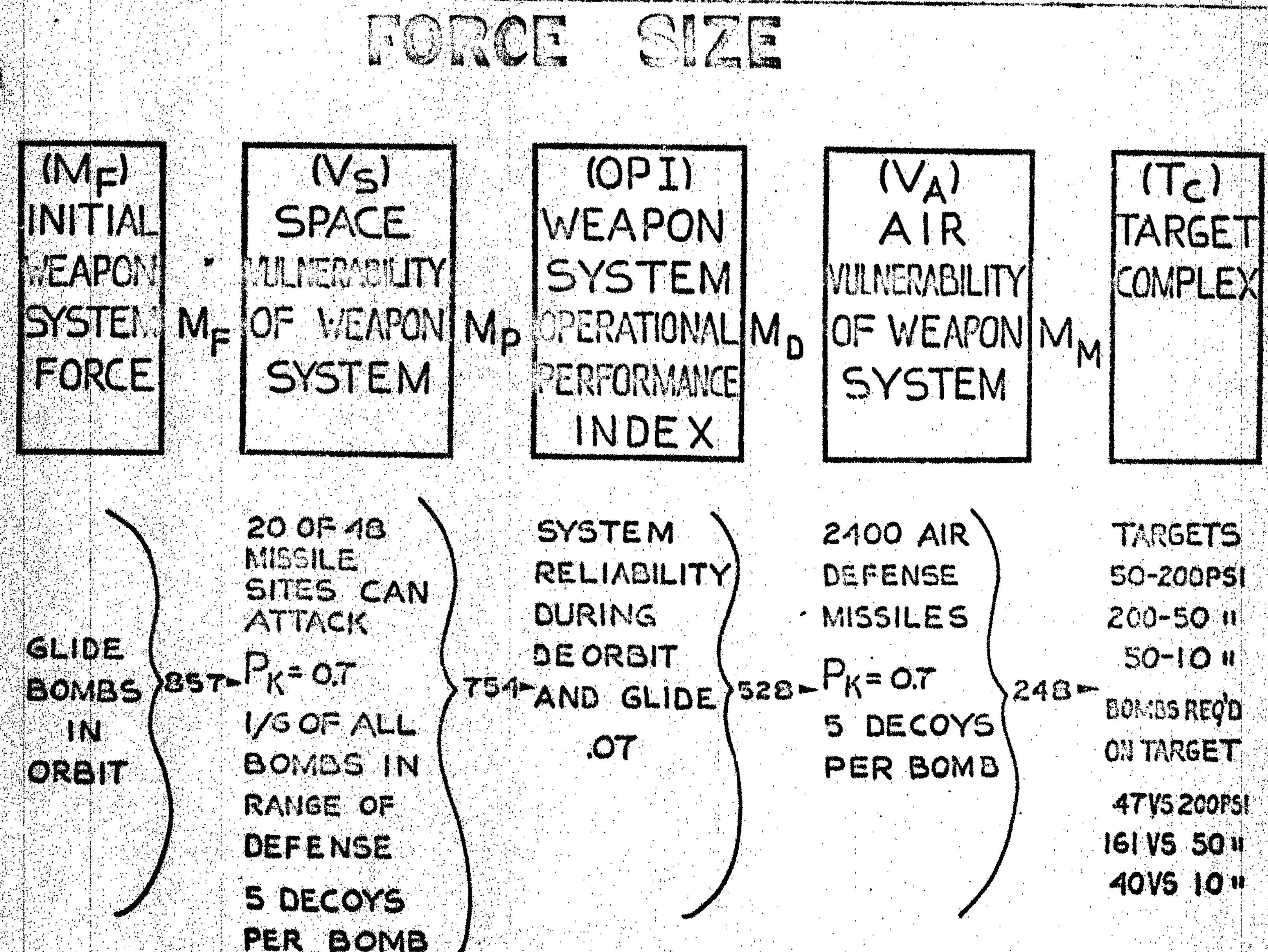


Figure IV B-25

IV. MULTI-ORBIT WEAPONS

C. MANNED LOGISTICS CARRIER AND RESCUE

1. Operational Concepts

The manned Logistics Carrier is a support vehicle to a multi-orbital system for maintainance, crew transfer and crew rescue. These functions are performed after the carrier has rendezvoused and makes contact with the orbiting vehicle.

For a service or inspection mission, the vehicle carries two men and their operational equipment. The vehicle is also capable of transferring the crew of the three man orbital reconnaissance vehicle. The interior design allows replacement of the single crew seat and equipment container with two seats. The vehicle can then take off with three men aboard, change crews and return to land.

A third alternate mission provides for rescue of the crew of a disabled orbital vehicle. In this arrangement, three men are returned in prone seats which are suitably designed for re-entry only.

The missions of the carrier involve rendezvous and join-up with satellites in orbits up to 300 N.M. above the earth's surface. Cruising flight to reach a satellite will be attained through a sage boost trajectory. Orbit changing operations are identical to those for the Satellite Inspector (Section IV.E.2). Mission flexibility is possible with variable load configurations.

A total of 30 operational Logistics Carriers may be required. The vehicles are located at other satellite launching bases, including one on or near the equator.

2. System Configuration

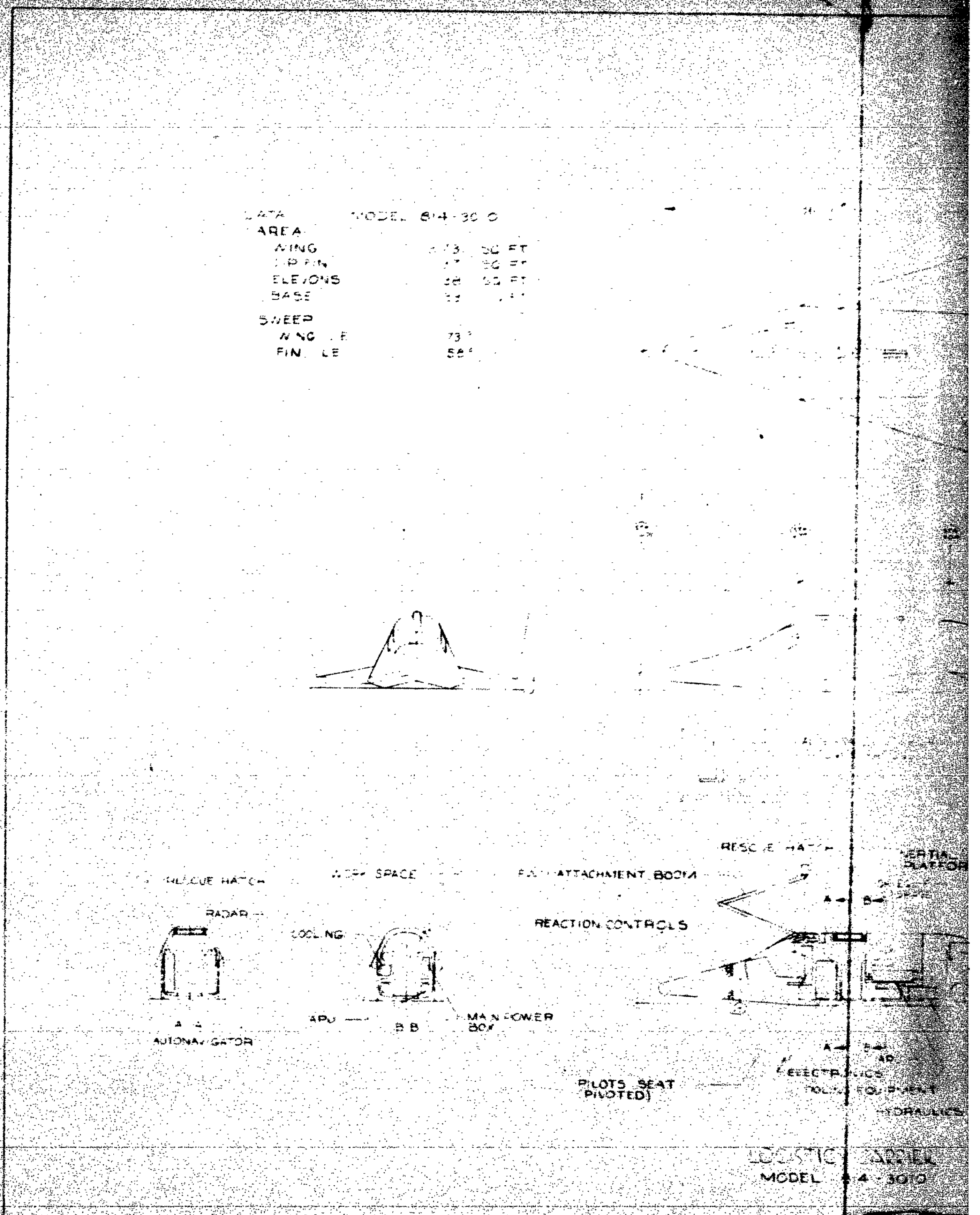
The manned logistics carrier is similar in external appearance to the DS-I vehicles. Due to the mission requirements, it is larger in size and carries a jettisonable fuel pod and engine at the back. Alternate loading permits additional liquid propellant fuel tanks to be carried for increased mission flexibility.

The orbit changing rocket is a liquid type allowing close control of the impulse requirements for contact. Orbit adjustment fuel would be supplied on the basis of approximately 450 pounds of fuel per orbit change and join-up. Join-up maneuvers are made using reaction controls and translating thrust jets, controllable in amplitude and duration.

The three grappling arms are positioned with one stowed along the top of the carrier and the others stowed in the final booster interstage structure. The three hinged arms are designed to withstand the foreseen tension and compression loads. Join-up with the Manned Orbital Reconnaissance vehicle is made in a top-to-top contact so the pilot can observe the maneuver. A communicating hatch connection is made following contact of the two vehicles.

A nozzle designed for the connecting arm attachment heads will provide reaction on the satellites' surface to eliminate any roll or pitching motion that may exist.

Incorporating a "tee" nozzle in the head automatically compensates for reaction and simplifies maneuvering control problems. Using the extendible arms for delicate motion arrestment at join-up protects both vehicles as the outrigger arm absorbs contact shocks. The attachment head on the arm contains a latch-unlock mechanism designed to couple with a socket on the satellite. The general arrangement of the manned logistic carrier is shown in Figure IV.C.1.



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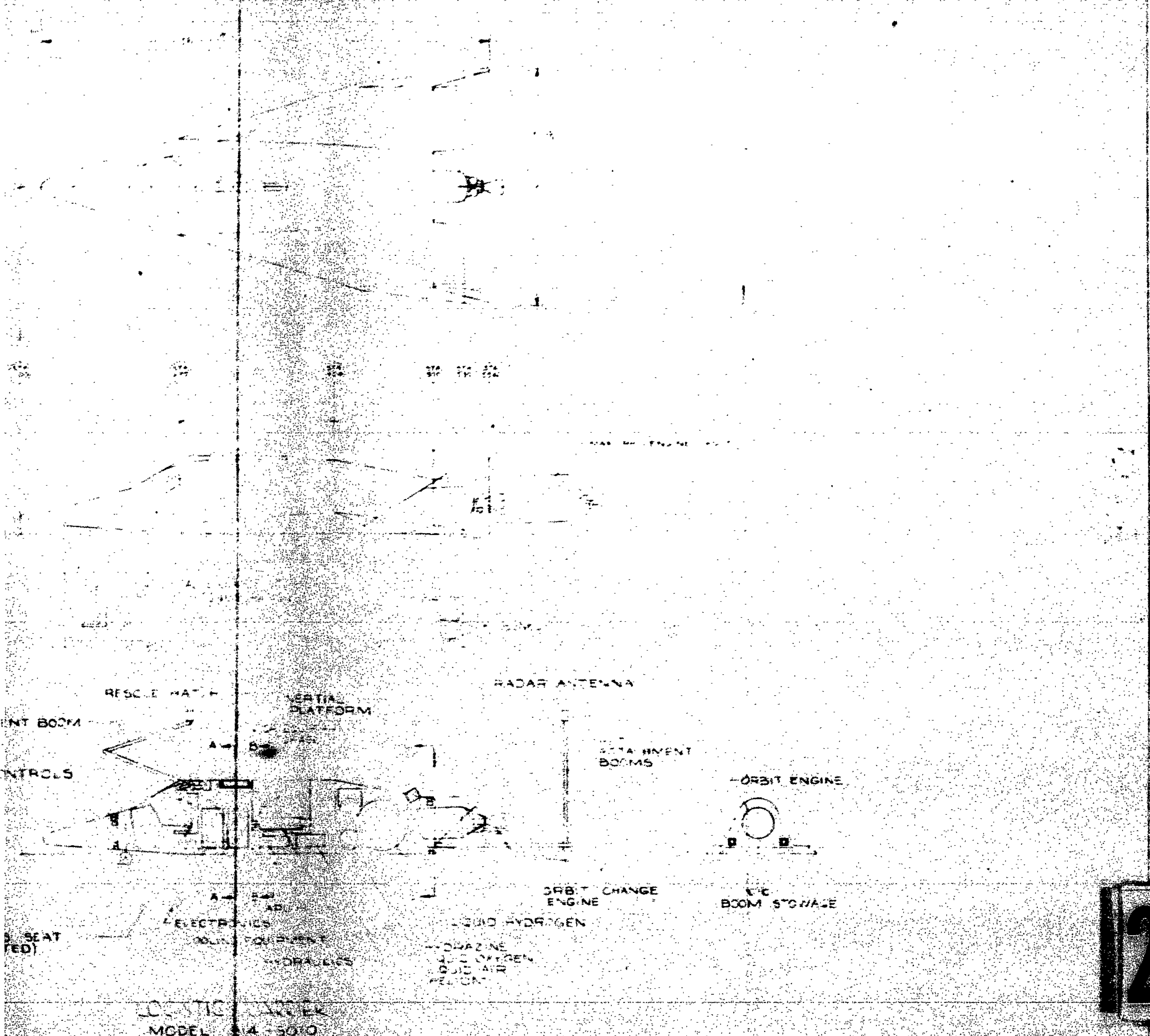

RESCUE HATCH
VERTICAL PLATFORM
RADAR ANTENNA
ATTACHMENT BOOMS
ORBIT ENGINE
ORBIT CHANGE ENGINE
BOOM STOWAGE
APU
ELECTRONICS
LIQUID HYDROGEN
HYDRAZINE
LIQUID OXYGEN
LIQUID AIR
MODEL

Figure IV.G.1

3. Ground Systems and Support

The Manned Logistics Carrier propulsion system is identical to that used for the Satellite Inspector weapon system (IV.E). External configurations, basic structure and equipment, and launch weights of the gliders used in the two systems are very similar. Vehicle force sizes are small and frequency of launching is low in both systems. Both systems require continental USA and equatorial bases.

Considerations of economy and operational efficiency, in conjunction with the similarities of the two systems noted above, makes joint use of bases both necessary and possible. The ground system described in some detail for the Satellite Inspector weapon system was planned on this basis. Ground system requirements for the Manned Logistics Carrier are adequately covered in this manner. Launching and maintenance crews can be shared, and possibly flight personnel as well. Additional support equipment peculiar to the Logistics Carrier vehicle and mission is necessary, but no change in the basic nature of the ground system described in IV.E is required.

IV. MULTI-ORBIT WEAPONS

D. ORBITAL ELECTRONIC COUNTER MEASURE WARHEAD-UNMANNED

1. Operational Concept

The orbital ECM warhead vehicle is an unmanned glider. It is used to carry a high yield warhead to a selected area which is then detonated to confuse and disrupt enemy defensive radars during an offensive ICGM or orbital Gldie Bomb attack. It will be de-orbited by rocket impulse, re-enter the atomosphere, recover and achieve stable flight, then follow a glide path to the target area. Alternately, a series of Electronic Counter Measure vehicles could be used to provide a corridor of attack ofr the offensive vehicles. Warheads would be detonated at altitudes of 125,000 to 150,000 feet creating a "blackout" or cloud effect trhough which the enemy defensive radars would be able to look. General information and quantative effects of this "blackout" are given in Reference 1.

The amount of signal attenuation is a direct function of the warhead size, the altitude of detonation, the angles of incidence, and the elapsed time following detonation. The objective concept is the same as for the Boost Glide ECM warhead given in III.G.1. The Operational concept is identical with that given for the orbital Glide Bomb, IV.B.1.

The requirement for accurate terminal guidance is eliminated, because of the high altitude at which the warhead would be detonated. This allows elimination of the "pinpoint" check point guidance. The resultant weight savings would be approximately 300 pounds.

2. System Configuration

The orbital electronic counter measure warhead is an unmanned orbital glide vehicle with the ability to "blackout" areas on

command or return to a recovery site for service. Specific performance and configuration details are identical with those of the orbital glide bomb given in IV.B.2.

Military subsystems information is the same as for the Boost Glide electronic counter measure warhead which are given in III.G.2-b.

Guidance and control requirements, with one exception, are identical with those for the orbital bomb given in IV.B.2-a. The exception is the "pinpoint" guidance system is not required.

Miscellaneous vehicle subsystem details are identical with those for the orbital glide bomb given in IV.B.2-d.

3. Ground Systems and Support

The ground systems and support requirements for the orbital bomb would not be appreciably affected by this ECM concept because of the vehicle and system similarity.

4. Force Size

Force size has not yet been determined as there are many trade-offs between vehicles required, depth of penetration, offensive force size and parameters such as range and time of "blackout" effectiveness.

IV. E. SATELLITE INSPECTOR, MANNED

1. Operational Concept

The Satellite Inspector is a manned multiorbital system to inspect and evaluate the threat potential, and if necessary, to neutralize orbiting satellites of unknown origin or function. To carry out the operations mission the Satellite Inspector must rendezvous with an orbiting satellite. The rendezvous technique is a two-step method as illustrated in Figure IV-E-1. The Satellite Inspector is placed in an orbit at a lower or higher altitude than the satellite to be inspected but in the same orbital plane. Since the orbits have different periods, the vehicles will approach and pass each other. At the proper point in the orbit the Satellite Inspector will change velocity, by means of the attached rockets, by an amount sufficient to bring the two satellites into close proximity. Another velocity increment can then be applied to place the two vehicles in the same orbit. The unknown vehicle can be inspected, and neutralized if required.

A second satellite in the same orbital plane can be inspected on the same mission by returning to a lower orbit, waiting there until the second satellite is overtaken and then accelerating to the satellite orbit as before. Alternatively, the Satellite Inspector can decelerate and go into an elliptical orbit until it catches up to the second satellite. In this way a number of satellites can be inspected on a single mission at a much lower cost than for separately launched inspection missions.

An alternative technique, which reduces the rocket energy requirements for rendezvous with one or more satellites in a single orbital plane, has been examined. When the inspector arrives within about one mile of the satellite, a cable is connected between the two and they rotate around each other. Upon completion of the inspection, the crew times the cable release from the satellite to utilize some of the satellite's kinetic energy for the next phase of the mission.

The Satellite Inspector is a system consisting of a two-man glider similar to the DS-1, liquid fueled recoverable first stage booster, second stage booster, and controllable orbit-changing motor, guidance and surveillance equipment, ground support equipment, and system support personnel.

The operational features of the system are:

(a) A two man crew to provide maneuvering, navigational, surveillance and neutralizing operations.

(b) Capability of launching into orbits of 300 n.m. and establishing a proximity, within 100 feet, with an orbiting satellite.

(c) Capability of inspecting and evaluating an orbiting satellite with radar, infrared and optical aids and Elint equipment.

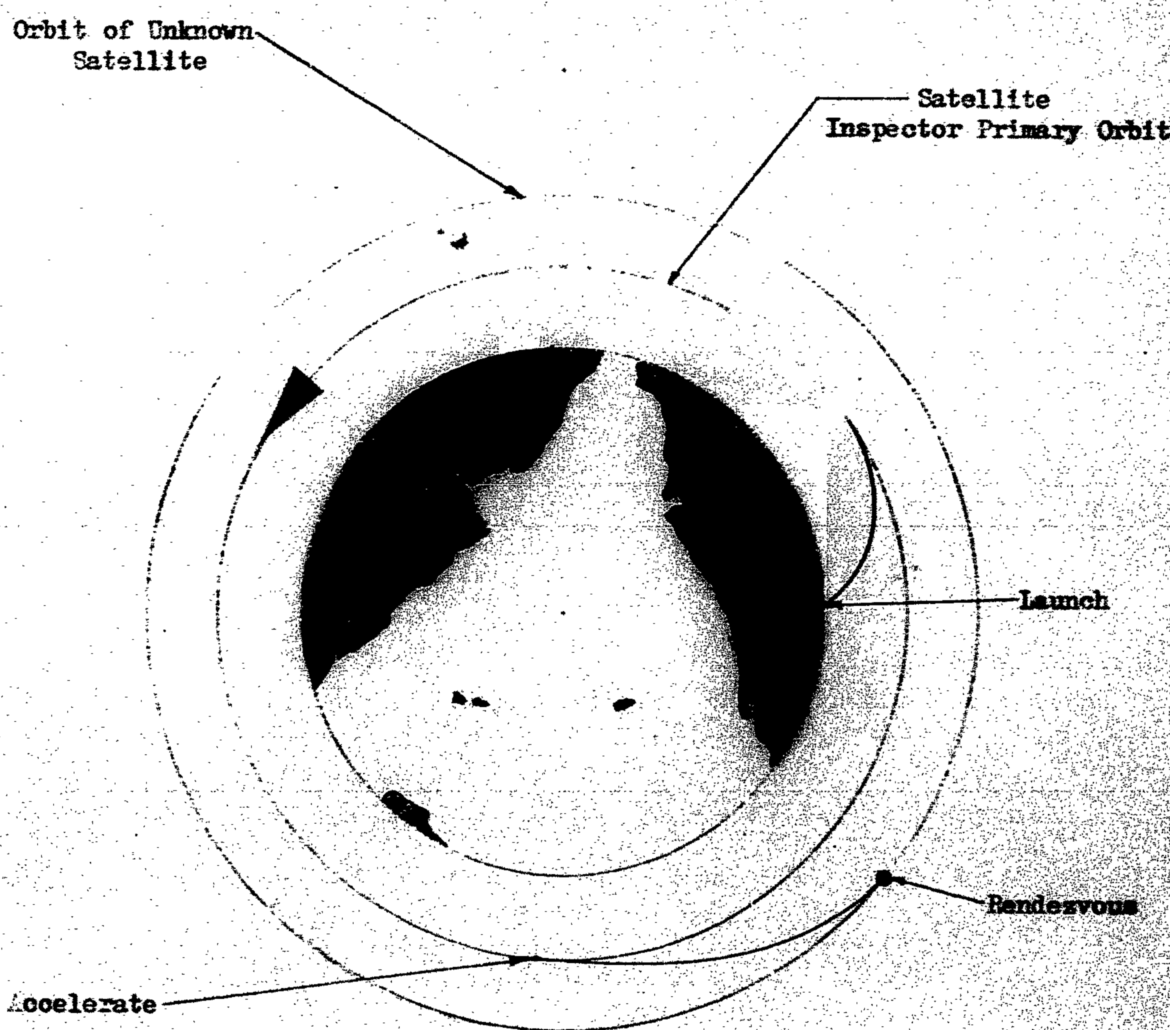
(d) Capability of neutralizing orbiting satellites by destroying sensor, communication or pressure envelope elements with machine gun fire.

(e) Capability of rendezvousing with a maximum of 10 satellites, in the same orbital plane, which average 100 n.m. apart.

(f) Maximum mission duration is 24 hours, plus 12 hours reserve.

(g) A total of 20 vehicles may be needed for the above operations. The vehicles are located so as to permit launching into any orbital plane. One launch base location will be required at approximately the equator. Christmas Island, a U.S.A. possession in the Pacific, is suggested.

Upon rendezvous with an orbiting satellite the crew performs the inspection and evaluation using infrared detectors, elint equipment and by direct visual surveillance through windows or periscopes. In event that the satellite offers a threat or is unfriendly, the Inspector destroys antennas and other sensor elements, or punctures the pressurized sections of the satellite with machine gun fire. After inspecting a satellite and taking appropriate action, the vehicle changes orbit to effect the next rendezvous or returns to a base. For re-entry the vehicle uses a de-orbit rocket to decelerate. After re-entry and deceleration to supersonic speeds the pilot maneuvers for a conventional landing. However, an automatic landing system is available to him.



SATELLITE INSPECTOR MISSION

Figure IV - E - 1

2. System Configuration

a. Performance and Configuration (Figure IV.E.2)

This vehicle is designed for the inspection, and as required, deactivation or destruction of satellites in orbits up to 300 n.m. above the earth's surface. Restricted missions with reduced loading, above 300 n.m. altitude are possible. Cruising flight to reach satellite orbit is attained through a safe boost trajectory which permits emergency escape at all times. The basic vehicle size is larger than that of the DS-1. The vehicle nose serves as a two man escape capsule, similar to the DS-1 escape system.

A jettisonable fuel supply and rocket motor for orbit changing operations is carried in the booster interstage structure, aft of the basic airframe. Since the interstage booster structure is jettisoned prior to carrier re-entry, aerodynamic properties of the vehicle are not compromised by the external storage.

Normal flight duration is 24 hours with 12 hours emergency for all missions.

Orbit adjustment fuel is supplied on the basis that approximately 450 pounds of fuel will be required to effect one satellite rendezvous. The orbit changing rocket uses a liquid motor since the impulse requirements must be adjusted as necessary for each rendezvous with a satellite.

Satellite neutralizing capabilities are possible with a single 50 cal. machine gun mounted in a simple turret which allows the gun to move out of its stowed position above the equipment bay.

Fire directional control is supplied by inputs from the surveillance radar subsystem.

The vehicle is normally landed by the pilot, who has optional use of an automatic landing system.

The rendezvous radar antenna and searchlight are retracted through the upper aft vehicle surface into a stowed position above the expendables storage bay. Windows are provided at both crew stations. Periscopes give the pilot a downward view and the observer an upward view.

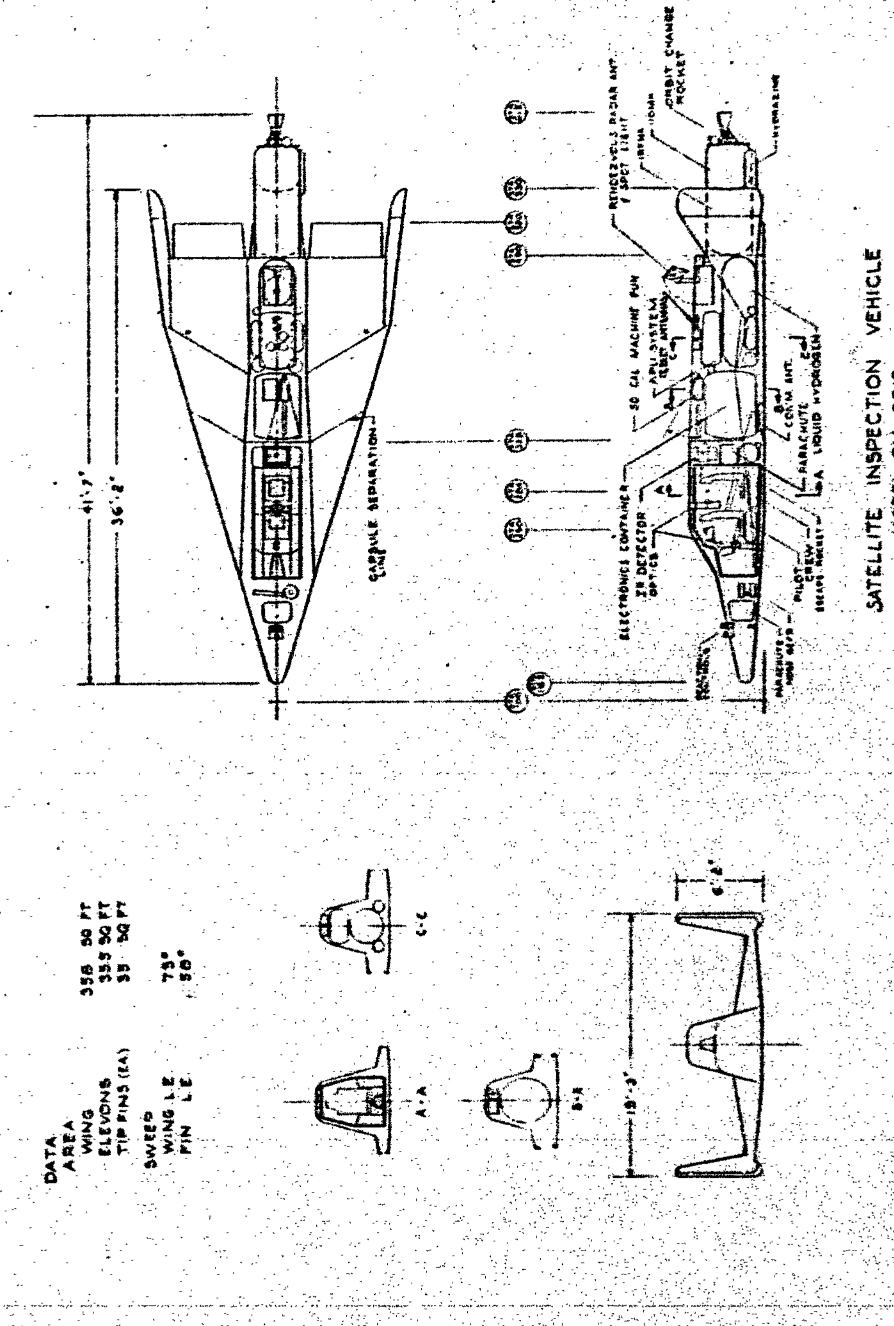

SATELLITE INSPECTION VEHICLE
MODEL 814-3012
DATA
AREA
WING 358 SQ FT
ELEVONS 35.5 SQ FT
TIP FINS (EA) 35 SQ FT
SWEEP
WING L.E. 73°
FIN L.E. 50°
CAPSULE SEPARATION LINE
ELECTRONICS CONTAINER
.50 CAL MACHINE GUN
PARACHUTE
LIQUID HYDROGEN
ORBIT CHANGE ROCKET
HYDRAZINE
A-A
B-B
C-C
19'-3"
41'-7"
36'-2"

Figure IV.E.2

Weight Data - Glider

Shown below is a preliminary weight statement for the Satellite Inspection vehicle including the expendable orbit changing engine and fuel required to perform a maximum of 10 orbit changes.

Item	Weight - Pounds	
Wing	880	
Body	2,390	
Fins	380	
Control Surfaces	460	
TOTAL STRUCTURE		4,110
CAPSULE SEPARATION ROCKET		170
Auxiliary Power System (Incl. 150 lb. fuel)	450	
Reaction Control System (Incl. 250 lb. fuel)	400	
Hydraulic System	100	
Electric System	300	
TOTAL SECONDARY POWER		1,250
Capsule Environmental Control (Incl. 210 lb. expendables)	840	
Glider Environmental Control (Incl. 50 lb. expendables)	550	
TOTAL ENVIRONMENTAL CONTROL		1,390
ELECTRONICS		1,600
FLIGHT CONTROLS		400
LANDING GEAR		300
CREW OPERATIONS (Incl. 2 crewman)		1,280
TOTAL GLIDER GROSS WEIGHT		10,500
Orbit Changing System Inert		500
Orbit Changing System Fuel		4,500
TOTAL GROSS WEIGHT		15,500

Decoy

Since the Satellite Inspector is unscheduled and generally has less than one day of orbiting, complicated decoys should not be required. It is planned to use spherical balloons, made of aluminized mylar, as decoys. These will be inflated and cast off on departure from the rendezvous vehicle. These decoys will weigh less than a pound. From 10 to 50 of these can be carried in the carrier depending upon the mission.

Booster System

The booster for the Manned Satellite Inspector is a two stage booster. It is the same configuration as the booster shown on Figure IV.A.5. The first stage is recoverable and employs liquid oxygen and liquid hydrocarbon for propellants. The second stage goes into orbit with the glider and is expendable.. It uses liquid oxygen and liquid hydrogen propellants. More detailed information on the booster system is contained in Section V.

The first stage attains a burnout velocity of 6,100 fps. The upper stage then has the capability to place a 15,500 pound glider (includes orbit matching capability) in a 300 N.M. altitude, circular, polar orbit.

Weight Statement

	Weight - Pounds
Glider	15,500
Second Stage	
Burnout	29,600
Propellant	127,500
Start Burning	157,100
First Stage	
Weight Empty	81,900
Pilot	250
Trapped Rocket Propellant	4,300
Turbojet Fuel	16,000
Propellant	432,000
Launch Weight	691,550

b. Guidance and Control

The Satellite Inspector vehicle has several novel guidance and control problems arising fxm its mission. The complete guidance and control system is outlined in Figure IV.E.3. Each phase of the mission will be described in turn.

(1) Launch Phase

The vehicle contains a basic precision inertial autonavigator for use during all phases. This navigator has adequate accuracy for launch. The launch control system is similar to that described for other Dyna Soar Vehicles.

(2) Rendezvous with a Satellite in Orbit

The existance of accurate satellite tracking and orbit computation stations in the United States is assumed for the time period of interest. The Satellite Inspector is launched into an orbit at a higher or lower altitude than the satellite to be inspected, but in the same orbital plane.

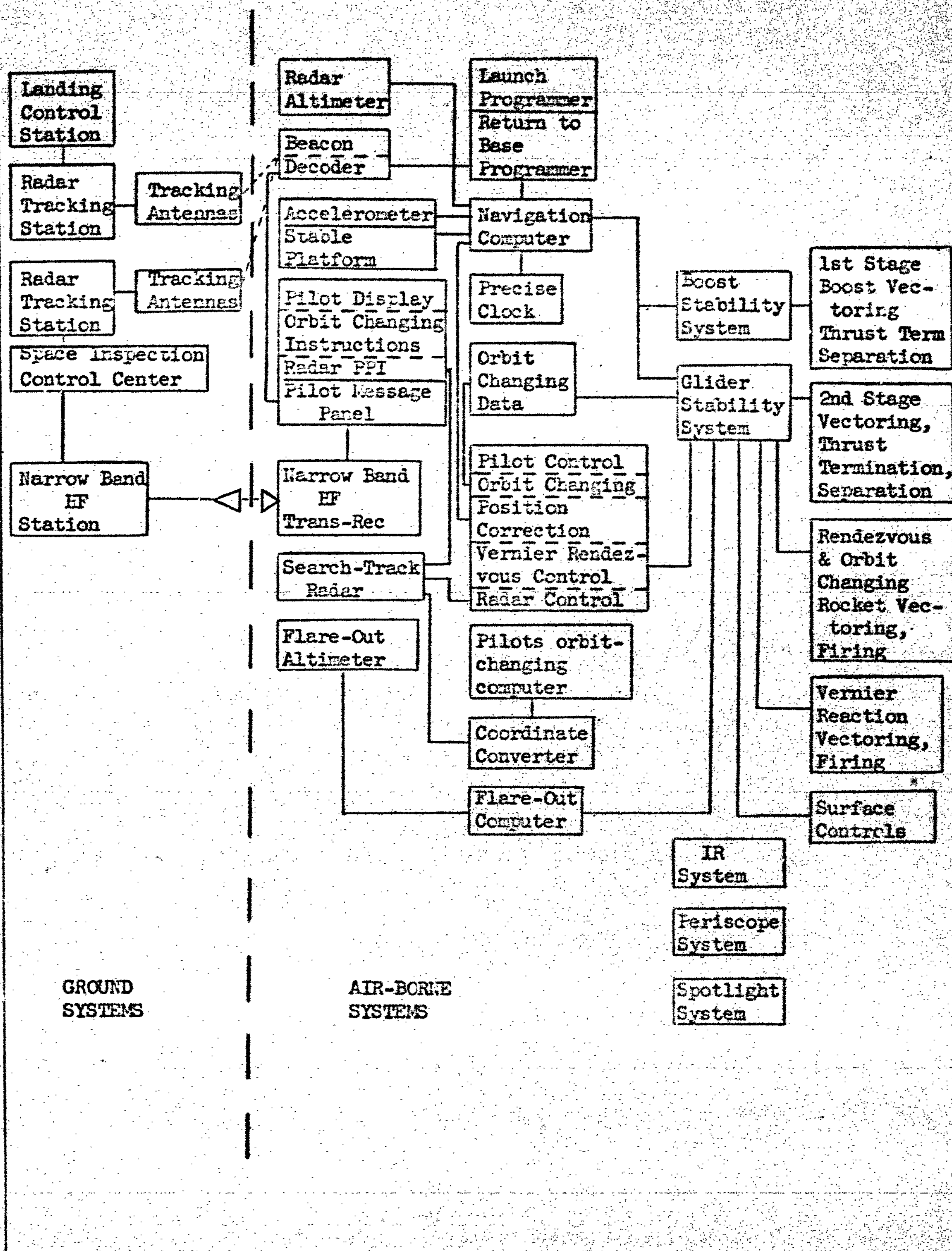
A small K-band search and track radar is used to locate the satellite position and determine its velocity. This data is entered into a semi-automatic "orbit changing" computer to determine the direction and magnitude of the maneuvering rocket impulse required to approach the satellite. To conserve rocket fuel the rendezvous operation may take an appreciable fraction of an orbit period. As the inspector closes to the satellite, the pilot fires his rockets to neutralized the closing velocity. He then maneuvers manually using vernier reaction controls to rendezvous within 100 feet. Optical aids, rendezvous radar and a spotlight are supplied to aid in this operation.

(3) Orbit Changing

The Satellite Inspector has the capability of rendezvous with up to ten separate satellites, in the same orbital plane, on one mission provided the separation of satellites does not average more than 100 miles. Instructions for changing from one orbit to another will have been furnished to the vehicle prior to take-off. These instructions can be automatically inserted into the vehicle control system when the pilot is ready to leave the present satellite under investigation.

If, due to unforeseen delays or change of plan, the predetermined instructions are no longer valid, the pilot can take either of two courses. He can request new instructions from the ground station through his narrow band HF communication system. Or, he can compute his own orbit changing procedure using the semi-automatic computer used for the initial rendezvous operation. This latter procedure will be less precise and will result in use of more rocket fuel than otherwise required.

For minimum use of rocket impulse the orbit changing operation may take an hour or more to complete. When the taxi orbital plane is inclined to the satellite plane, the taxi waits until it crosses the latter and then changes course into the satellite plane. In order to "catch-up" or "slow-down" to the satellite the taxi will change its radial velocity, thus changing the angular rate at which it rotates around the earth.



(Figure IV E-3.) GUIDANCE AND CONTROL: SATELLITE INSPECTOR

A rocket impulse capability for orbit changing of 500 feet/sec. for each change is required on the average.

(4) Return to Base

Return to base instructions are provided prior to take-off. If the mission does not go according to plan, the pilot can either request new instructions from the ground or use the orbit-changing computer to calculate them himself.

Otherwise, the landing system is the same as for other Dyna Soar vehicles.

To avoid excessive accumulation of navigation error during a prolonged mission, the navigator can be corrected periodically upon rendezvous with a satellite (the satellite's orbit has been accurately determined prior to take-off) or upon passing over one of the United States tracking stations. In this way navigation errors can be kept below 20 miles, which is more than adequate for landing.

Communications

UHF Voice Transceivers: A system for two-way voice communication for landing instructions from tower and for communicating with other vehicles is included. This transceiver has been described in earlier sections of the document.

Infra-red Detection: will be supplied to assist in tracking and surveillance functions.

c. Miscellaneous Vehicle Subsystem

(1) This vehicle has a flight duration of 24 to 36 hours, with a normal electrical load of several kilowatts (Figure IV.E-4)

	LAUNCH	TARGET	GLIDE	LAND
GUIDANCE & CONTROL				
Radio Guidance	65			
Platform Electronics	400	400	400	400
Computer	350	350	350	350
Orbit Changer Computer		20		
Flight Control Elect.	310	310	310	310
Landing System				270
RECONNAISSANCE		1500		
COMMUNICATIONS				
Landing Beacon				100
UHF Transceiver				200
Narrow-Band Receiver	100	100	100	100
Narrow-Band Transmitter	400	400	400	400
ELECTRONIC LOAD TOTAL	1625	3080		
EQUIPMENT BLOWER CABIN BLOWER, LIGHTS	1000	200	200	1000
TOTAL ELECTRIC LOAD	2625	3280	1760	3130 W.
HYDRAULICS (2 SYSTEMS)				34 H.P.

FIG. IVE-4. SECONDARY POWER - LOAD ANALYSIS

and a high hydraulic load during re-entry. Possible energy sources considered include fuel cells, hydrogen-oxygen APU's, sunshine, and nuclear energy. The last two would not be available during re-entry.

The peak re-entry requirement could be handled with hydraulic pumps driven by hydrazine APU's or hydrogen-oxygen engines. The short flight time permits the use of liquid hydrogen and oxygen for fuel, and this choice gives a specific fuel consumption substantially lower than available from a hydrazine APU. Electric power during cruise is most economically furnished by the hydrogen-oxygen engines.

The requirement of immediate readiness can be met by keeping the liquified gas tanks filled at all times. Calculations based on new installations indicate that a 5% per month boiloff is possible, and a tank that is topped once every two weeks would need to be only about 3% oversize.

In the resulting system (Figure IV.D-5), fuel from insulated tanks is vaporized in a heat exchanger where it absorbs equipment - compartment heat. The fuel then goes to two positive displacement engines. Each engine drives an A.C. generator feeding an A.C. bus. The generators are automatical-ly paralleled. A transformer-rectifier provides D.C. power. Each engine also drives a hydraulic pump which supplies hydraulic power to the flight control actuators. Associated with each of the pumps is a hydraulic unit consisting of an accumulator, a reservoir, a relief valve, a filter, a pressure switch, and necessary valving, lines and fittings.

At the required operating altitudes aerodynamic controls are ineffective. Attitude control during this phase of flight will be provided from a reaction control system. This system will share a common fuel supply with the hydrogen-oxygen engines. The entire secondary power system including the heat exchanger is contained in a single integrated package.

(2) Escape System

The escape system for the Satellite Inspector is similar to that for the Satelloid Reconnaissance System (See Section III.B.3e), except that provisions are made for a two man crew.

(3) Environmental Control

The vehicle has two pressurized, conditioned compartments which contain the bulk of the glider equipment and crew. A limited amount of cooling is accomplished outside the compartments.

The cabin compartment contains the life support system. The atmosphere of nitrogen and oxygen is maintained at 8.3 psia. Atmospheric leakage is held to 1 pound per hour. Oxygen partial pressure is 3.08 psia (sea level equivalent). The temperature is controllable from 50° to 90°F. Relative humidity is maintained at 40% ± 10%, and carbon dioxide partial pressure is less than 4 mm Hg. (0.93% concentration) through the incorporation of chemical absorbers. Cooling is accomplished by circulating the atmosphere through an ethylene glycol-water heat exchanger from which the heat is transported to a liquid hydrogen heat exchanger. The liquid hydrogen fuel on the way to the secondary power system engines provides the heat sink for both the cabin and equipment compartment systems. Passive water cooling is used on the outside of the cabin pressure shell to

absorb aerodynamic heating during re-entry.

The aft compartment contains most of the vehicle electronic and other temperature sensitive equipment. A separate environmental control system provides cooling by circulating a cold nitrogen gas atmosphere. Compartment pressure is maintained at 10 psia. and leakage is held to 1 pound per hour. Aerodynamic heat entering the aft compartment is removed by the circulating nitrogen gas. A schematic diagram of the environmental control systems is shown in Figure IV.E.7

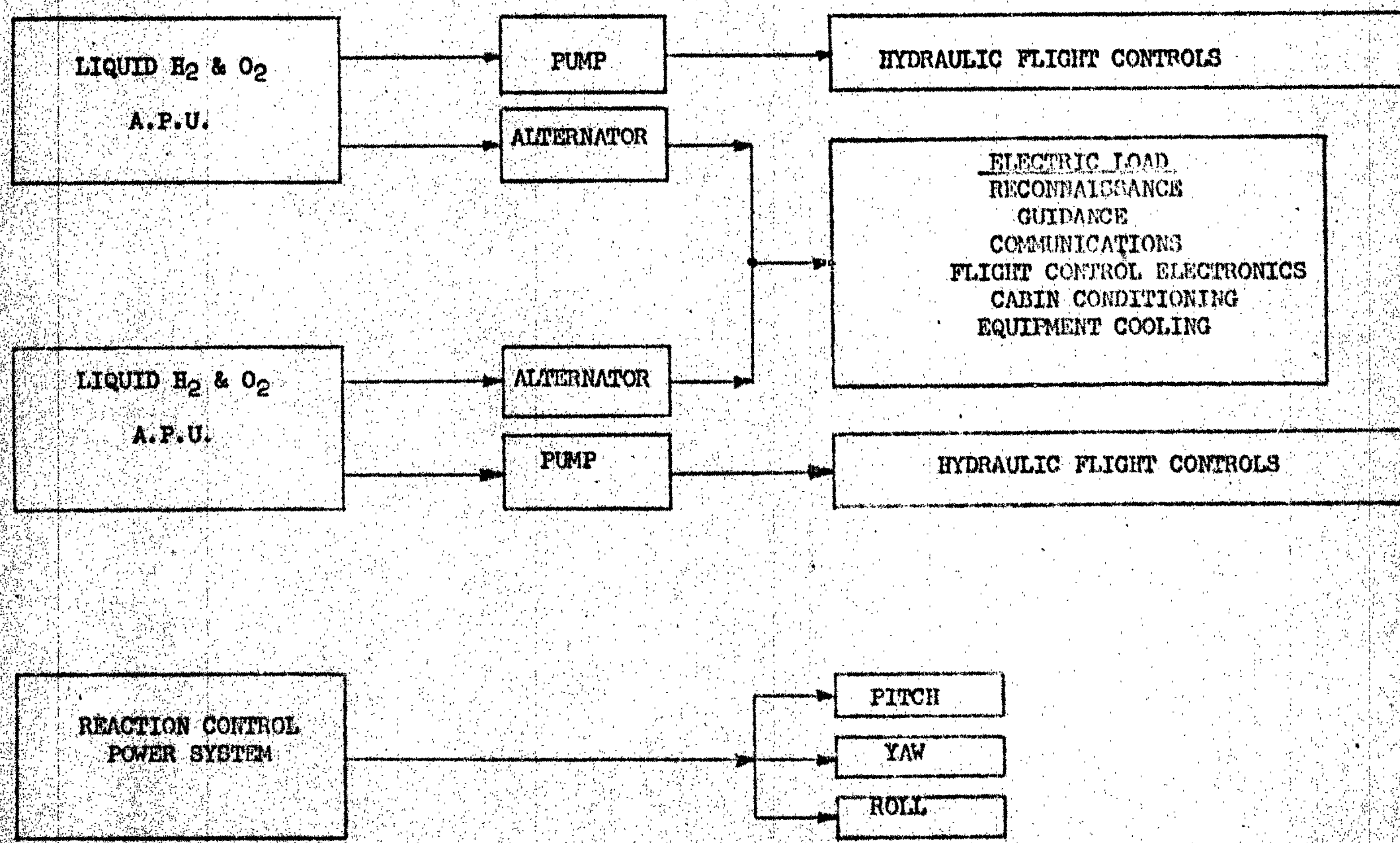
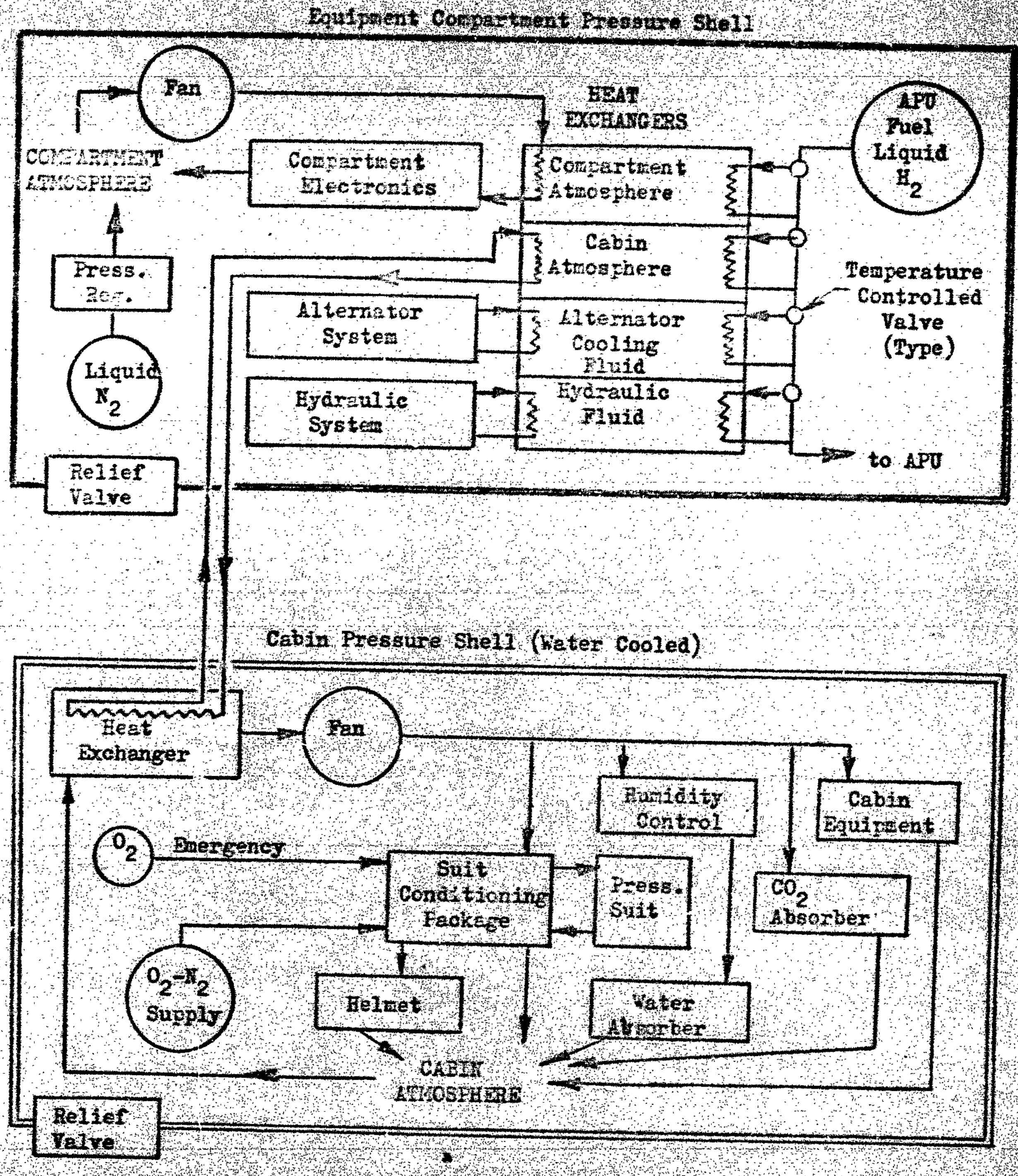


FIG. IVE-5. POWER SUPPLY



ENVIRONMENTAL CONTROL SYSTEM

Figure IV.E.6

3. Ground Systems and Support

Satellite Inspection System

a. Introduction

(1) During the basic design of the vehicle and its supporting elements, Ground Support requirements are given balanced consideration with other major design parameters such as performance, weight, producibility, etc. As a major part of the overall operational concept the ground support requirements are established concurrently with the airborne vehicle requirements. Full advantage is taken of the experience gained on preceeding systems to assure continuing improvement in the maintainability and supportability characteristics of the weapon system.

(2) The ground system described herein covers the following system elements:

Base Complex
- Operational Base Location and Facilities
- Tracking Base Location
- Runways
- Assembly and Test Areas Hazardous and Non-Hazardous Items
- Launch Sites
- Launch Control Centers

Sequence of Operations
- Airborne Vehicle Assembly
- Vehicle Emplacement at Launch Site
- Launch and Monitor Functions
- Glider Recovery

Ground Support Equipment and Facilities

Ground Cooperational Equipment

Spares and Supply
Maintenance Concept
Personnel Support

(3) Certain key ground rules place limiting functions on the derivation of ground systems for this operational concept. These ground rules cover:

(a) Need for locating a portion of the force at a base which permits equatorial or near equatorial orbits within practical boost size limitations.

(b) The relatively low number of required operational missions.

These ground rules impose the need for a base near the equator which supports a relatively small force of operational vehicles, in addition to a larger force based within the continental limits of the United States.

Specific ground rules used in this study are:

Force Size:	Approximately 20 vehicles
Launch Rate:	Average; one per week Maximum; one per day for 14 days. One fourth of all launches are from an equatorial base.
Reaction Time:	One hour.
Reload Time:	As required to meet specified launch rate.
Boost Configuration:	First Stage LOX & RP-1 Piloted and Recoverable 61,900 lbs empty Second Stage $H_2 + O_2$ Burns up on re-entry 8400 lbs empty
Glider Weight:	11,000 lbs (includes 500 lbs for in-orbit propulsion system)

Total Launch Weight:	691,550
Vulnerability:	No Portection Required
Recoverable Booster Life:	250 Flights
Glider Life:	30 Flights
Fuel Requirements Per Flight:	O_2 408,500 lbs. RP - 1 134,200 lbs. H_2 21,250 lbs.
First Stage Maintenance:	Per North American Document MD 59-44 (Reference 2)
Mean Time to Failure:	Glider; 12 months Second Stage; 12 months First Stage; one minor malfunction per month - 4 hours down time; One major malfunction per year requires replacement of entire vehicle.
Logistics Carrier System:	The operational vehicles for this system can share the same base as the Satellite Inspector. Gliders are similar. Boost stages are identical.
First Stage Flight Range:	Can be self-transported by air to island base.

b. Base Complex

Mainland Base:

The main operational base is located in the Southern part of the United States and is centered around an existing airbase. Short range boost training flights can be launched from Vandenburg Air Force Base.

At the operational base and at several other airbases throughout the United States, 8,000 to 10,000 foot runways equipped with automatic landing equipment installations are available. These runways are provided with arresting gear for emergency use only,

Near each runway are facilities for decontamination of the glider and removal of the air-crew. However, any 10,000 foot military base runway can be used for emergency recovery of both first stage or glider.

Facilities provided on this base include base assembly buildings, office buildings, training facilities and simulators, launch pads, fuel storage facilities, LOX generating plant, power stations, communications and landing system facilities. Liquid Hydrogen may be generated on the base or transported in,depending on the availability of raw materials and power.

Completely assembled vehicles are moved to the launch site from the final assembly storage by rail,in a vertical position. Three operational launch pads are provided to meet the launch rate requirements of the system. Each site is provided with insulated LOX storage tanks for fueling the vehicle immediately prior to launch. Insulated liquid hydrogen tanks are located at the site for fueling the second stage boost engine.

Each launch site is equipped with a set of electrical launch equipment which furnishes missile system status information to a central control station during the launch sequence. Each site has a launch tower for umbilical connection, autocollimator and pilot access elevator.

Launch site separation is one mile between sites and from the final assembly area.

Equatorial Base:

The equatorial base, located on an island such as Christmas Island, is essentially an auxiliary launch site for the mainland base. Because of the very low launch rate, operations will be designed to require a minimum number of facilities and equipment at this base. Base facilities needed are a final assembly and vehicle storage area provided with final acceptance functional checkout set and monitor equipment, two launch pads, and towers, a maintenance building for the first stage boost and a 10,000 foot runway. Transportable liquid storage tanks are used in lieu of the fixed storage tanks used on the mainland base. See Figure IVE.7

c. Sequence of Operations

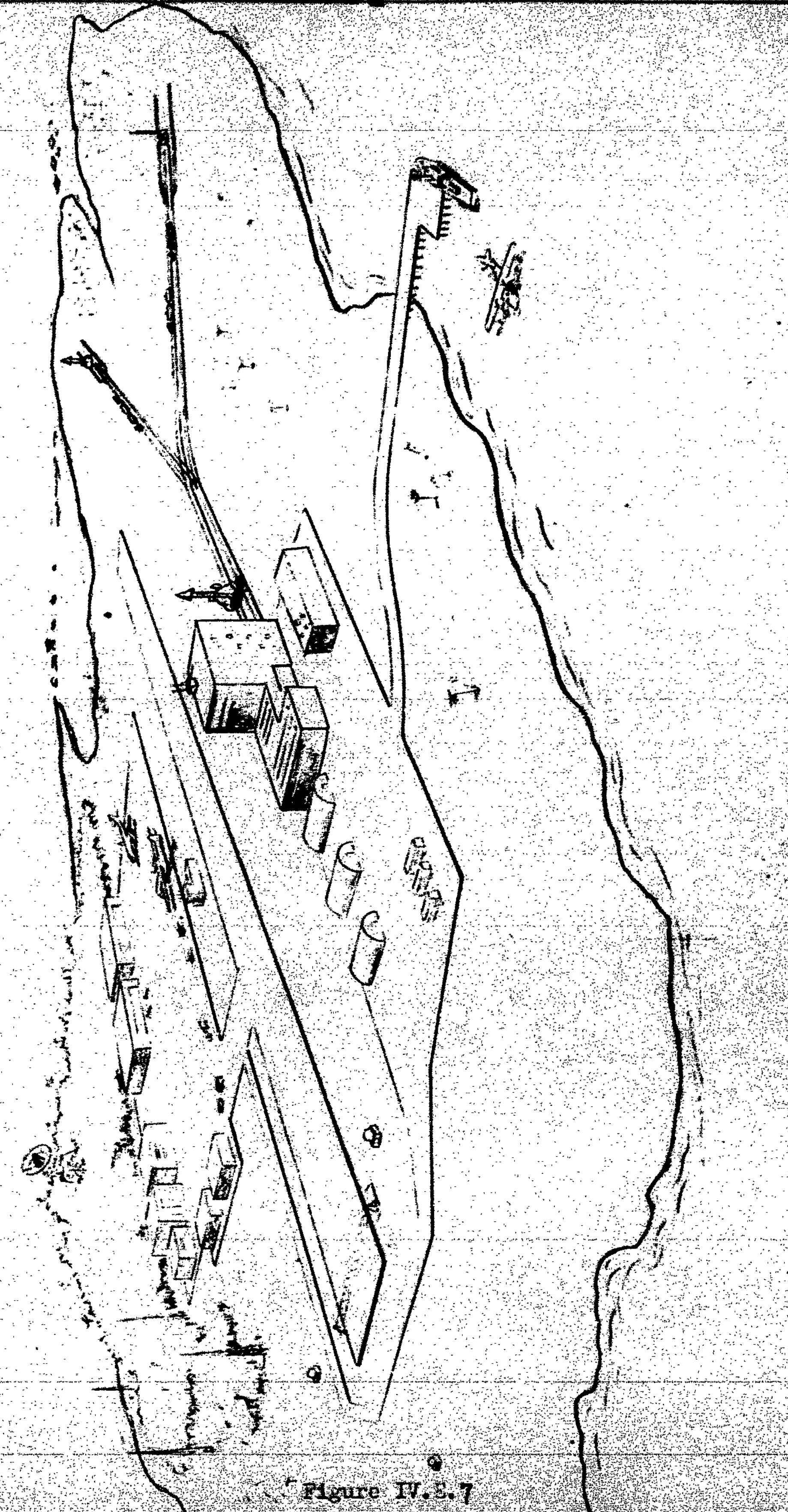
(1) Mainland Base (See Figure IV.E.8).

Major vehicle sections defined as (1) first stage recoverable boosters, (2) second stage liquid booster engine and (3) gliders will be received as follows:

First stage recoverable boosters are received on a fly-in basis from the manufacturer. These boosters are received complete with all non-integrated flight systems, such as communications, beacons, etc.

Upon acceptance, the boosters are transferred, on their own gear, to a storage area. From this area, they are fed into the final assembly area per schedule requirements.

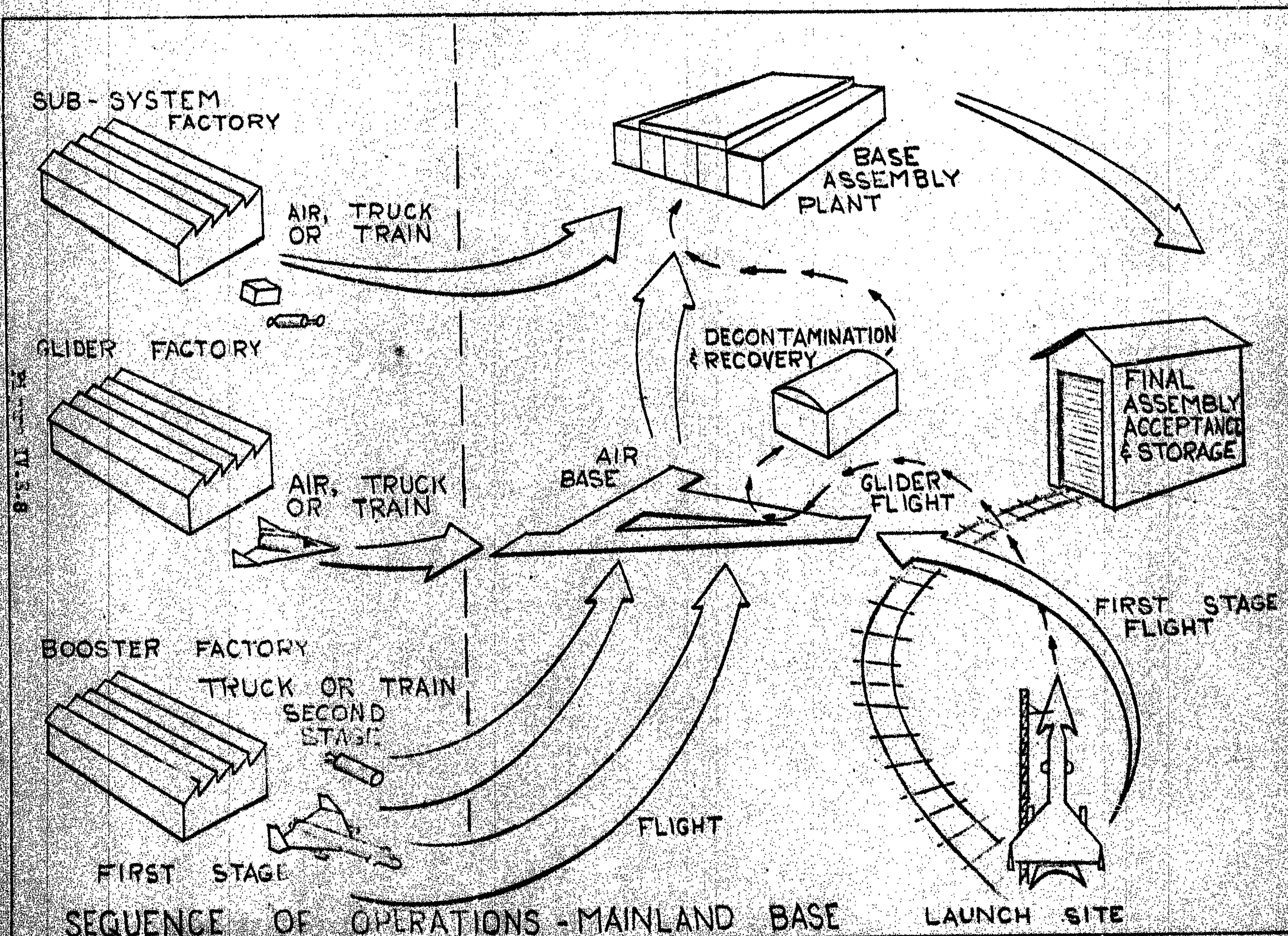
Second stage engines are received in end opening, metal containers. A visual inspection is performed and the accepted engines are transferred to a storage area. In accordance with the assembly



SATELLITE INSP & FINAL ASSY. AREA - EQUATOREAL BASE

Figure IV.E.7

IV



SEQUENCE OF OPERATIONS - MAINLAND BASE

Figure IV.3.8

operations schedule, the engines are removed from their metal containers and transported on dollies to the engine assembly area where functional equipment, interstage structure, etc. are attached. Each built-up engine is inspected and after acceptance, is held in storage or transferred to the final assembly area as required.

Basic glider structure is received, by rail or air, from the manufacturer, complete with all non-integrated flight systems, such as voice communication equipment, radar beacons, mechanical control linkage, conditioning equipment, etc.

This grouping arrives mounted on a combined transportation unit which serves as shipping fixture, in-plant transportation and storage dolly, and protective cover. After visual inspection the assembly is stored or routed to the final glider assembly station as required. Glider equipment subsystems are received as major assembly packages. Integrated subsystems are built up through several levels of assembly, into an integrated functional unit, with functional tests performed at each level to indicate satisfactory integration of the subassembly packages.

Finally, the glider structure and the integrated functional subsystems are combined and functionally tested as a complete glider assembly. The complete glider is stored or routed to vehicle final assembly as required.

The boost stage power unit and servo systems for the second stage are assembled as an integrated package and transported to the assembly area as required for individual boost engine

build-up.

At the final assembly area a fixed assembly jig is provided where the three major sections of the vehicle are assembled in a vertical position on a transportable launch platform. Work platforms for assembly personnel are an integral part of the assembly jig.

Upon completion of assembly, a final acceptance functional checkout is made and the vehicle is transferred to the ready storage area or to the launching pad on its transportable launch base. Prior to ready storage or pad transfer the vehicles are fueled with RP-1.

Vehicles in ready storage are monitored periodically. Malfunctions are isolated by the monitor equipment to the three major sections (glider, second stage liquid boost, and first stage recoverable boost). If a malfunction is indicated, the vehicle is defueled, purged, and moved back to the final assembly area for major section replacement.

As operations require, the flight vehicle is moved to a launch pad. When fueling with LOX is completed, liquid stores are topped off and the pilots enter their cockpits through the elevator in the launch control tower. Two vehicles are sent to launch pads for each firing, one of which provides back up if the scheduled vehicle fails in countdown. Countdown functions are monitored by the pilots, the monitor and ELE operators in the launch control center. Any one of these men can abort the mission by not keying into the launch circuit.

Booster Recovery

The first stage booster lands at the base upon completion of its mission and is defueled and purged. It is towed to the first stage maintenance area where operational airbase personnel checkout the non-integrated flight systems, base assembly personnel checkout the booster systems and upon completion of required maintenance, the booster is recycled through the airborne vehicle final assembly process.

Glider Recovery

After landing, the glider is retrieved on a special handling vehicle and taken to the decontamination area where it is cleaned preparatory to further processing. The pilots remain in the glider during decontamination to avoid exposure to residual radiation. Immediately thereafter, the glider is moved to the second processing stage, where the pilots leave the glider. The glider is returned to the launch base for maintenance and re-use.

(2) Equatorial Base (See Figure IV.E.9)

Airborne Vehicle Preparation

Glider and second stage booster are received from the mainland base by airlift or ship as completely assembled and functionally checked major assemblies. Recoverable first stage is flown in as an airplane.

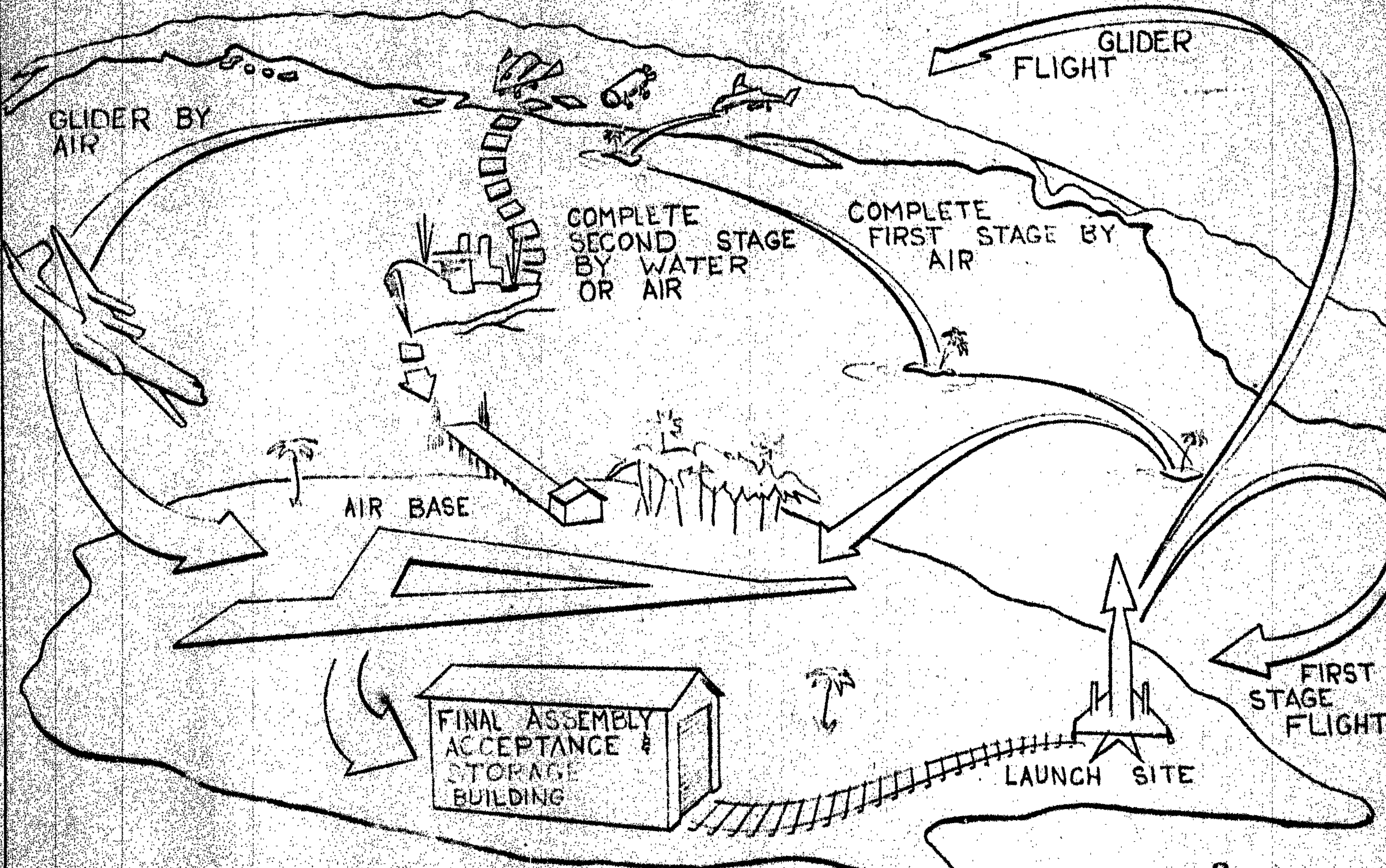


Figure IV.E. 9

SEQUENCE OF OPERATIONS - EQUATORIAL BASE

SATELLITE INSPECTION SYSTEM

Final assembly storage and launch operations are the same as on the mainland base. Recovery operations are identical except that glider is recovered at the same mainland bases as mainland launched gliders.

d. Ground Support Equipment and Facilities

Items of support equipment required after factory completion of components, but not directly associated with the operational firing aspects of a weapon, fall into this category. For the Satellite Inspection System, these would include the handling fixtures, dollies, beams, slings, work stands, special tools, major assembly test sets, functional checkout equipment, test set calibration equipment, recovery vehicles, decontamination equipment, shipping containers and servicing equipment described in previous sections. In addition, this system will require:

Transportable Launch Base

The transportable launch base consists of a rectangular frame on railroad trucks. It is used as a base for vehicle assembly in the A & T plant and supports the vehicle in a vertical position during assembly and storage and transport to the launch pad. The transporter is moved over two pairs (four rails) of standard railroad by means of a large tug.

Cryogenic Tank Cars

Railroad box cars containing specially insulated tanks are required for transport of liquid hydrogen to the base if this material is not generated locally.

Liquid Oxygen Plant

A liquid oxygen generating plant is required on the mainland base to provide LOX as necessary for the operational mission. Insulated tank trucks transport LOX to the storage tanks at the launch sites.

Transportable Cryogenic Tank

Transportable insulated tanks are used to furnish required cryogenic fuels to the equatorial base and serve as storage tanks until pre-launch fueling operations. The empty tanks are returned to the mainland and replaced by full tanks for the next launch operation.

Docking Facilities

A loading dock is required at the equatorial base for the handling of all material and flight vehicle sections which are transported by surface vessels.

e. Ground Cooperational Equipment

This category of equipment is defined as those items and facilities directly involved in and required during a missile launch operation. For the Satellite Inspection system, the major item in addition to the arresting gear and monitor and control equipment is the Launch Control Tower.

Launch Control Tower

A control tower is required adjacent to each support pad to support the umbilical and the piping required for servicing the vehicle before launch. The tower is equipped with an elevator for elevating the flight crew to their stations and for transporting equipment

and supplies as required. Within the main tower is a second tower for supporting the inertial guidance autocollimator. This tower is protected by the main tower but entirely isolated so as to prevent movement or vibration from being transmitted from the main tower to the autocollimator.

f. Spares and Supply

Mainland Base

Although specific spares requirements cannot be established until vehicle and booster configurations have been closely defined and other matters of a logistics nature have been clarified, it is neverless possible to outline certain principles to which an efficient spares and supply plan must conform.

(1) The spares and supply plan will be based on considerations of minimum stock levels, minimum pipeline time, direct support from source to user, and minimum administration at the base level.

(2) Electronic Data Processing Equipment and Communications are used to link the Weapon System Management with operating squadrons, storage sites, and the contractor.

(3) Control Objectives include:

a) Accountability centrally controlled by the Weapon System Management.

b) Minimum administration at operational level.

c) Contractor repair and overhaul of peculiar items.

d) Air Materiel Area repair and overhaul of common and standard items.

e) Limited inventory at base level, as only "remove and replace" type components are stocked.

f) No distribution to base level of "bits and pieces" for repair and overhaul.

g) Reliability data collection for product improvement programs.

h) Rapid, reliable spares handling and instantaneous inventory.

Cryogenic supply system is designed to minimize transfer of liquids where possible to minimize evaporational losses.

Equatorial Base

The number of operations performed at the equatorial base is kept to a minimum to reduce the load on the supply system. Cryogenic materials are shipped in containers which are used for launch site storage.

Except for the non-integrated systems such as voice communication radio, conditioning equipment etc., and minor first stage airplane type equipment, the spares level for the airborne vehicle is the major vehicle section.

g. Maintenance Concept

Mainland Base

The completely assembled airborne vehicle is monitored periodically in the storage area. Electrical launch equipment at the pad can also indicate the existence of a failure in the airborne vehicle. In either case, the vehicle is recycled through the assembly plant in a reverse direction.

Equatorial Base

Maintenance is handled in the same manner at the island location except that vehicle sections are recycled to the mainland base for repair.

h. Personnel Support

Further study is required to determine training and manning requirements for this system. Approximate numbers of personnel required are:

Mainland Base	
Direct Support	1000*
Flight Personnel	85*
Equatorial Base	600
Flight Personnel	21

* 60% of Mainland personnel support chargeable to Logistics Carrier System.

i. Concept Study Items

1. Base Locations

   Continental United States

   Equatorial

2. Recoverable Problem

   Cost

3. Cryogenic Reload Time: One Hour

4. Despite apparent logistic problems associated with island base locations, investigate the use of a single island base vs. island supplementary base.

   Potential Benefits

Reduced ground support investment and operating costs.

No Booster fall-out problems

Potential Difficulties

Supply Logistics

IV. E.4 **Human Factors Considerations**

The overall human factors implications for the study program is discussed in Section VII. However, there are certain specific problem areas and considerations which should be raised in the present context to provide additional emphasis.

The general space rendevous mission concept, provides for programmed flight profiles to within some one hundred (100) feet of the target satellite. At this point, the crew provides manual inputs for the final approach. The accomplishment of the final vernier control maneuvers depends to a considerable extent on presenting the pilot with appropriate information concerning rate of closure to target, and, the means for excercising positive control over the intercepting vehicle. There are several potential sensors available, namely, radar, infrared and direct vision. In choosing one or all of these sources, a significant problem is raised in what is the most effective means of presenting the information to the crew? Likewise, what will the control configuration be? In answering this question it is necessary to determine the capability of the human operation for integrating the distance from interceptor to satellite vehicles.

The use of direct vision must be evaluated from the point of view of perception in the intense lights and darks of outer space. The problems of form detection and discrimination, motion detection and visual illusions have been extensively studied in the earth environment. This information will be

necessary in evaluating the use of direct vision in space rendezvous maneuvers. Extensive binocular systems may be necessary to compensate for the lack of curves for distance perception, or, redundancy may be required to some extreme degree. In addition, it will be necessary to investigate crew requirements for computational devices, equipment and procedures. What are the requirements for information storage and handling on board the vehicle? What information, static and dynamic , can be expected, routinely, or on call, from ground stations?

Through all of the above questions and problems areas we have the paramount consideration of the human capabilities competing with equipment counterparts for inclusion in the system. The incorporation of man as a component of space systems requires the most efficient and effective use be made of this component in order to compensate for system penalties which his presence entails.

IV. MULTI-ORBIT WEAPONS

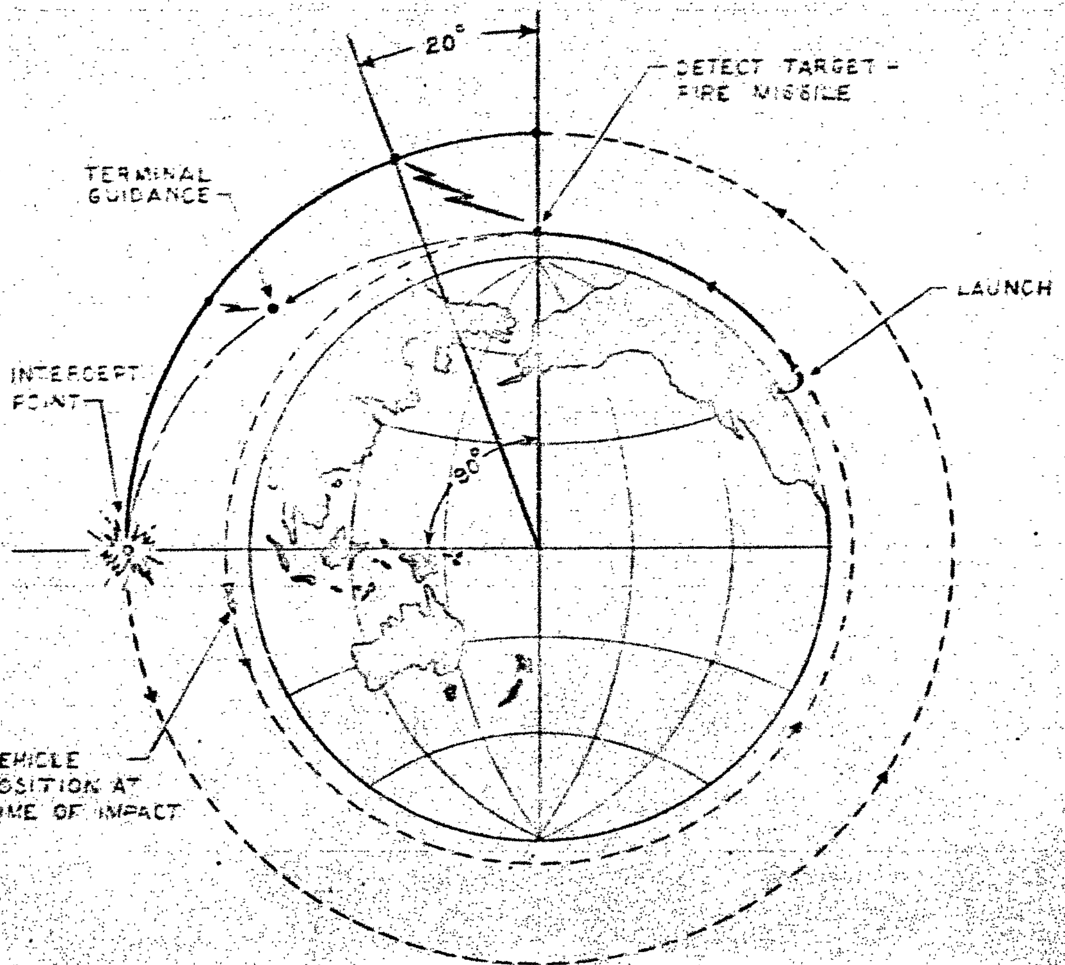
F. MANNED, SATELLITE INTERCEPTOR

1. Operational Concept

The satellite interceptor is a manned recoverable, boost glide vehicle with limited duration, orbital capabilities. It is a modification of the DS-1 configuration with provisions for carrying a number of attached missiles. The mission of the interceptor is to examine and/or destroy satellites which may be hostile. Actual inspection and destruction of the enemy is accomplished by missiles which are launched from the interceptor.

Initial detection and tracking of satellite objects are accomplished by ground installations. Data obtained on satellite objects is relayed to the interceptor bases where launch conditions are determined. At the exact time the launch site passes into the orbital plane of the satellite, the interceptor is boosted into a 150-mile altitude co-planar orbit. The vehicle travels in the same direction as the object to be inspected. A typical mission is shown in Figure IVF-1.

Upon reaching the 150-mile altitude the interceptor uses its higher orbital angular velocity to gain on the target until missile firing position is achieved. Data in the satellite position is stored in the interceptor and corrected from ground tracking stations thru a data link. A pilot's display is used to present the crewman with visual information on the satellite position, the interceptor's position, and the correct position and time for missile launch. The pilot has the option to fire manually by over-riding



MISSILE INTERCEPT TRAJECTORY

For missions where the satellite is to be inspected, a missile containing a TV scanner is utilized. The missile is initially guided by an inertial system to approximately 40 miles from the target. At this point the detection and tracking system achieves "lock on" and directs the missile to within 100 ft. of the satellite. The TV data obtained by the scanner is relayed to the pilot of the interceptor and to a recording system in the vehicle. After inspection the pilot has the option to detonate a small high yield warhead in the inspector missile thus destroying the satellite.

For missions where the satellite or satellites are to be destroyed, the attacks are carried on in a similar manner to the inspection mission. No television scanning is provided. For multiple targets, the interceptor remains in orbit and continues to gain on the other targets. As the firing position is reached, the attacking procedure is carried out against each satellite. The interceptor is recovered following destruction of the last target or after expenditure of its missiles. When an acceptable re-entry position is obtained, the pilot performs a lifting re-entry and a controlled descent to a selected landing site. The pilot's instruments, displays, controls and flight technique are similar to those of the DS-1.

2. System Configuration

a. Performance and Configuration

The satellite interceptor is a manned, hypersonic boost glide vehicle capable of carrying externally mounted missiles into a limited duration orbital flight. An orbital altitude of 150 miles is used for the interceptor, this is based upon consideration of interception times for hostile satellites assumed to be in orbits which range from 100 to 1000 miles altitude.

The vehicle is basically the DS-1 with modifications to permit the inclusions of military subsystems, other communication systems, increased power generation equipment and environmental control system capacity, and externally mounted missiles. The modifications are required to provide the capability for directing missile attacks or satellite surveillance. The longer flight durations of approximately 15 hours and increased electronic heat dissipation loads also require revisions in the environmental control systems. The vehicle structure is modified to carry 3 to 5 missiles externally on the upper surfaces of the body as shown in Figure IV.F.2.

The vehicle is boosted in a "safe" trajectory to the desired orbital conditions. Thus in case of premature thrust termination, recovery is accomplished without exceeding the vehicle or pilot's physical limitations. The basic glider with three missiles weighs approximately 9670 pounds.

The booster for the Manned Satellite Interceptor vehicle is a two stage booster. It is the same configuration as the booster shown on Figure IV.B.4. The first stage is recoverable. It uses liquid oxygen and liquid hydrocarbon propellants. The second stage goes into orbit with the glider and is expendable. It uses liquid oxygen and liquid hydrogen propellants. See Section V for more information on boosters.

The first stage attains a burnout velocity of 8,800 fps. The upper stage then has the capability to place a 9,670 pound glider in a circular, polar orbit with an altitude about 500 N.M. To boost to lower altitudes the upper stage would not be fully loaded with propellants.

The basic vehicle weight is:

Airframe	3670 lbs.
Propulsion (Escape Cap.)	220 "
Crew Accommodations	550 "
Secondary Power	950 "
Environmental Control	1160 "
Flight Controls	225 "
Mechanisms	255 "
Electronics	530 "
Total	7560 Lbs.

The missile installed weight is:

Three Missiles per Vehicle	1860 lbs.
Launching System & Installation	250 "
Total	2110 lbs.

The total vehicle weight at launch is:

	Weight - Pounds
Glider	9,670
Second Stage	
Burnout	14,970
Propellant	47,300
Start Burning	62,270
First Stage	
Weight Empty	81,900
Pilot	250
Trapped Rocket Propellants	4,300
Turbojet Fuel	16,000
Propellant	432,000
Launch Weight	596,720

Interceptor Missile

The missile is equipped with a high yield warhead (up to 15 KT) which has a weight of 50 pounds based upon 1965 technology. A CEP of 100 feet is provided by the terminal guidance system which consists of an IR target seeker, inertial platform, and computer. Data from this system is utilized to control the propulsion impulse and correct midcourse guidance errors. Inertial guidance controls the missile flight until the IR seeker has "locked on" the target at approximately 40 miles

range. During the terminal phase, the IR system measures the rate of rotation of the line of sight between the target and the missile. The rate is reduced to zero by controlling the missile flight path thru its propulsion system. A proximity fuse detonates the warhead as the missile and the target close.

The missiles are carried in launch tubes arranged on the aft upper sections of the body as shown in Figure IVF-2. The location minimizes drag effects in exit flight and aerodynamic heating, and eliminates interference with the capsule separation and air brake extensions. The launch tubes raise the missiles above the fuselage parallel to the datum line, and they also provide a means of protecting the missiles from external hazards. The launcher is elevated for firing and jettisoned after the missile is launched. The launchers also serve to protect the missiles if they are carried on the vehicle during re-entry.

Orbital Interception

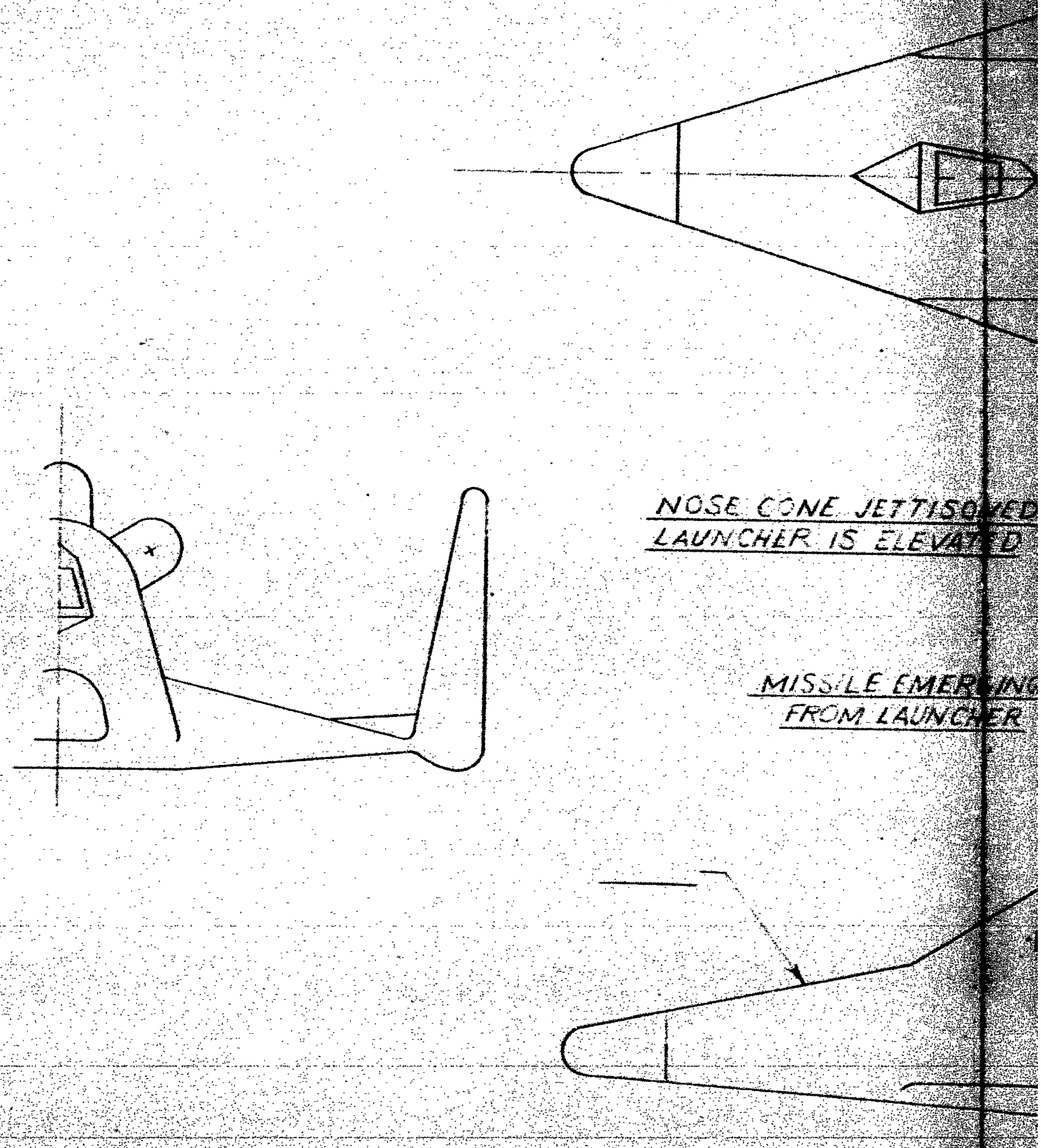
The orbital interception of enemy satellites is based upon detection and tracking of the target by an early warning system. Target orbital plane and altitude are computed from the tracking data. A launch site position closest to the enemy orbital plane is chosen and launch occurs as the earth's rotation carries the site into the desired firing position. Two launch sites have been chosen and the waiting periods computed for various USSR longitude positions is shown in Figure IV.F.3. The effects of target altitude and angular separation on maximum time to achieve launch position is demonstrated in Figure IV.F.4.

It appears that the most profitable orbits for vehicles launched from the USSR are those whose plane in inclined from 60° to 90° relative to the equator. For purpose of analyses, two interceptor launching sites, Cape Canaveral, Florida and Pt. Arguello, California are utilized in the determination of total time to target interception. Figure IV.F.5 illustrates the time to achieve firing position for an interceptor launched from Cape Canaveral based upon target altitudes of 500 and 1,000 nautical miles. Figure IV.F.6 shows the total intercept times for the two geographical sites.

More detailed information on the airborne interceptor studies is contained in reference 9.

NOTE:

AFTER MISSILE IS FIRED, LAUNCHING TUBE IS JETTISONED



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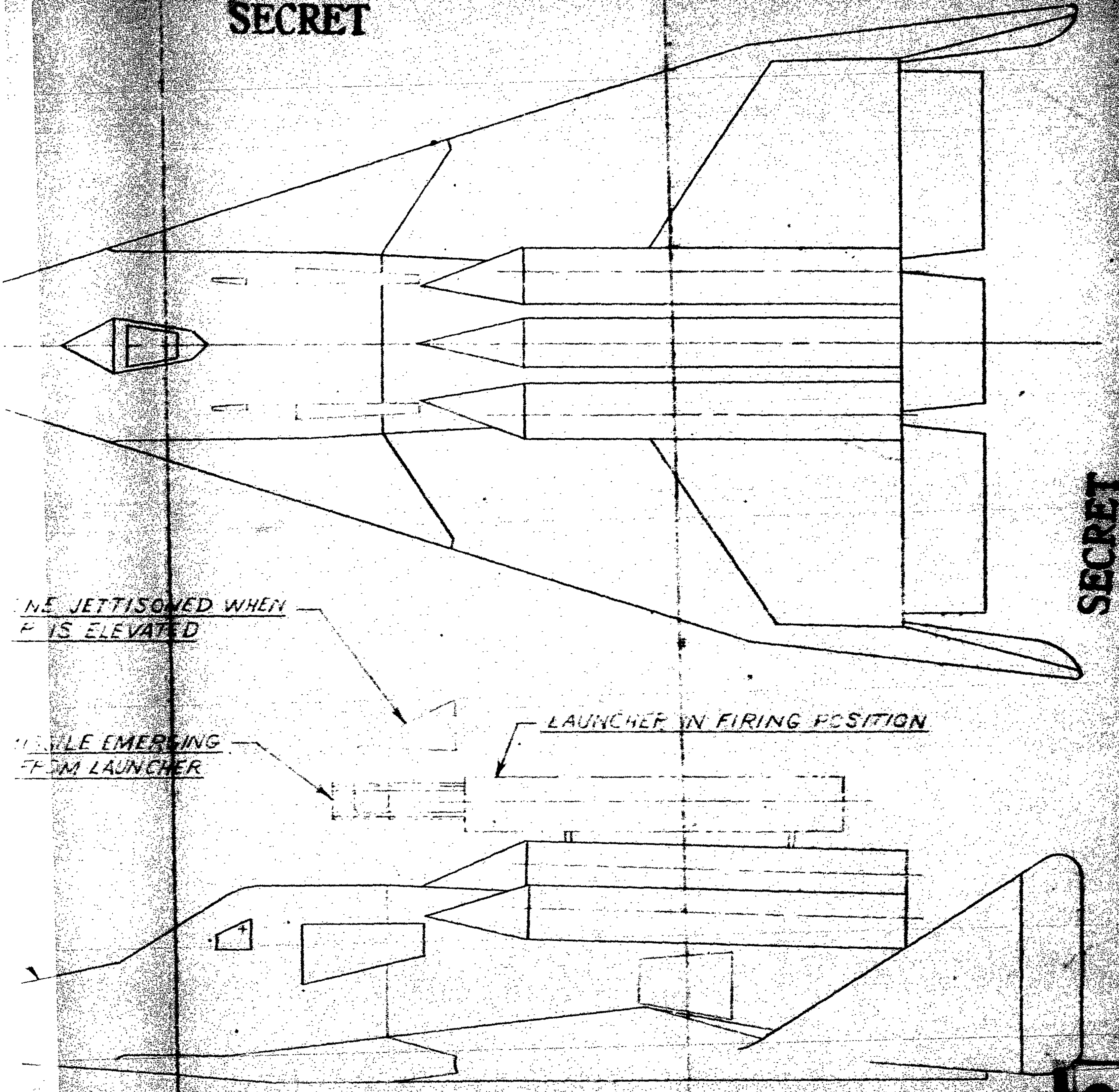

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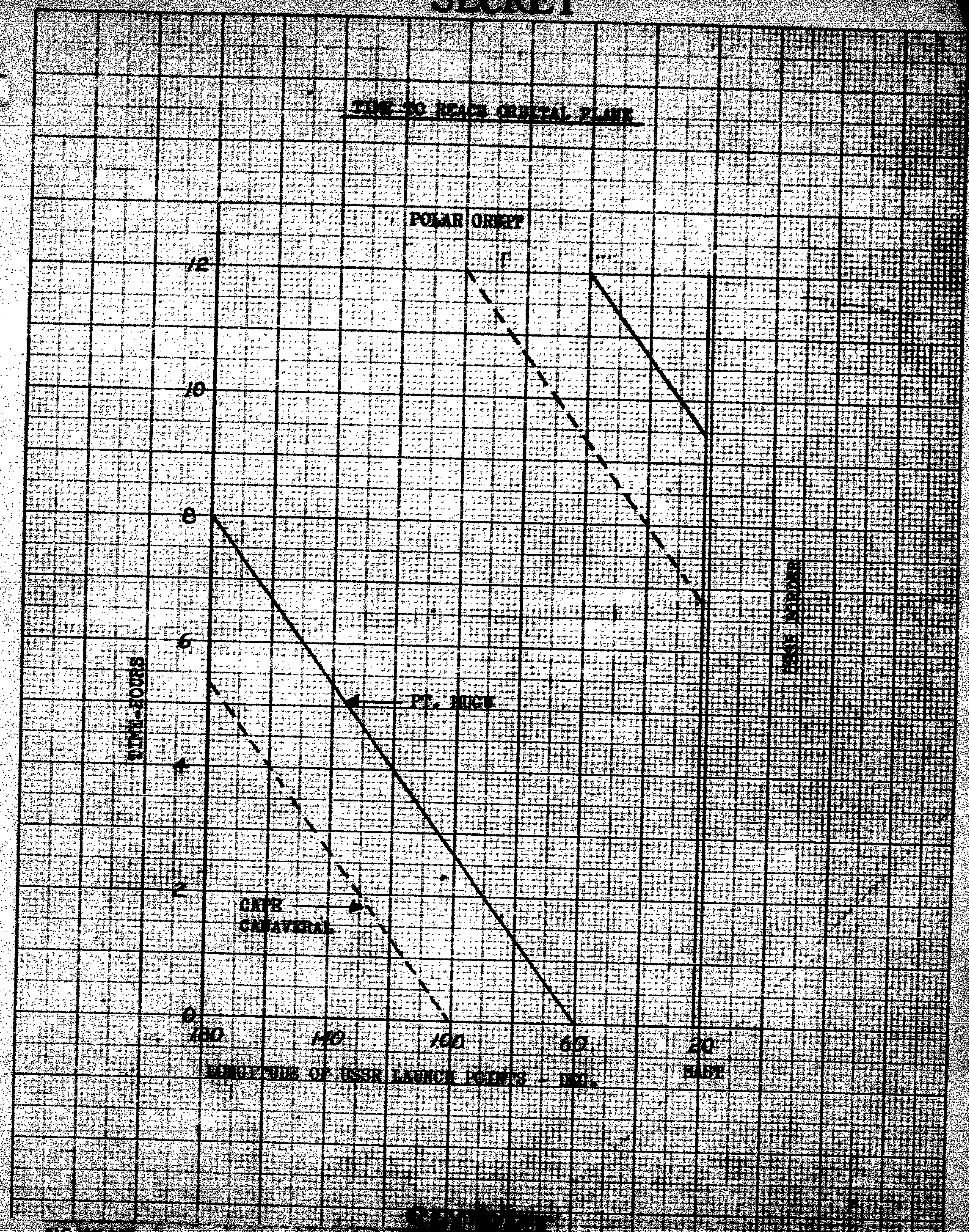
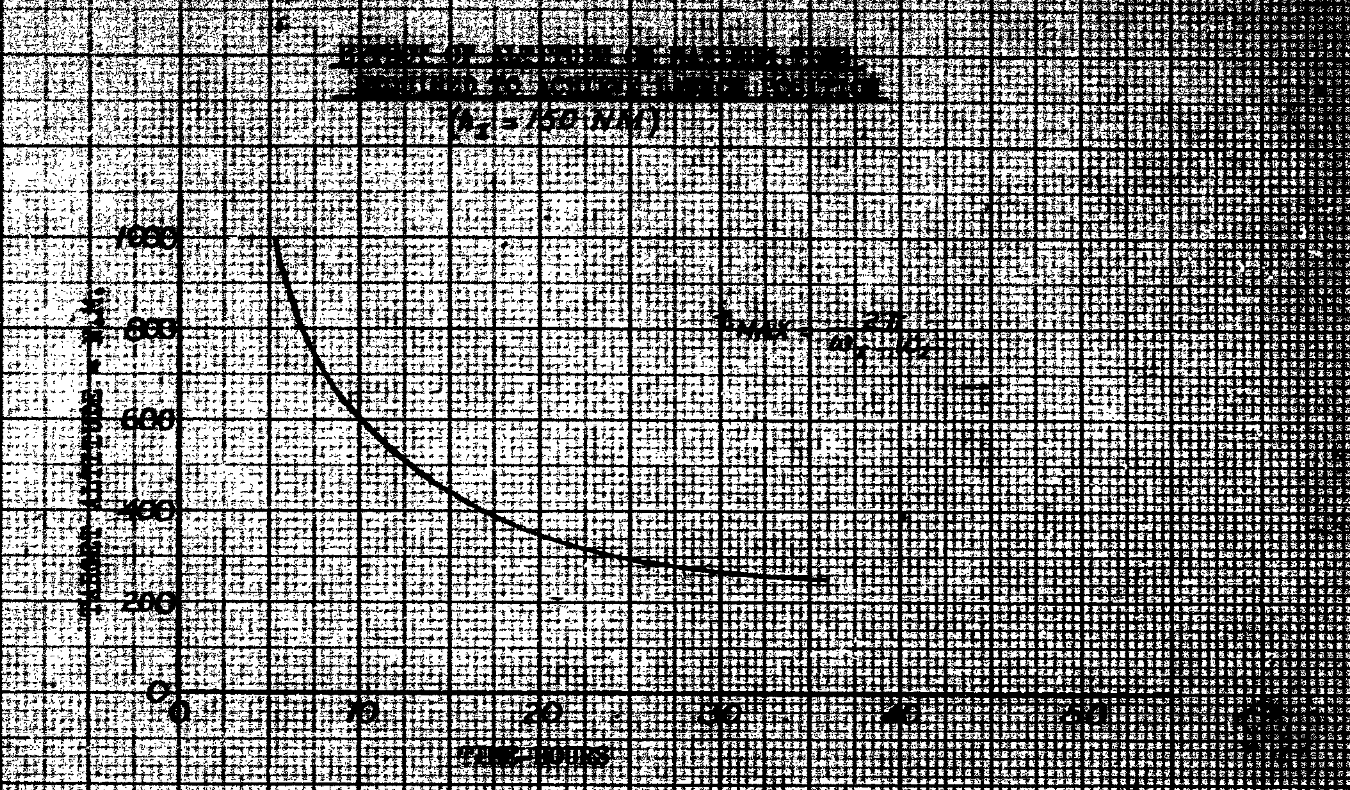
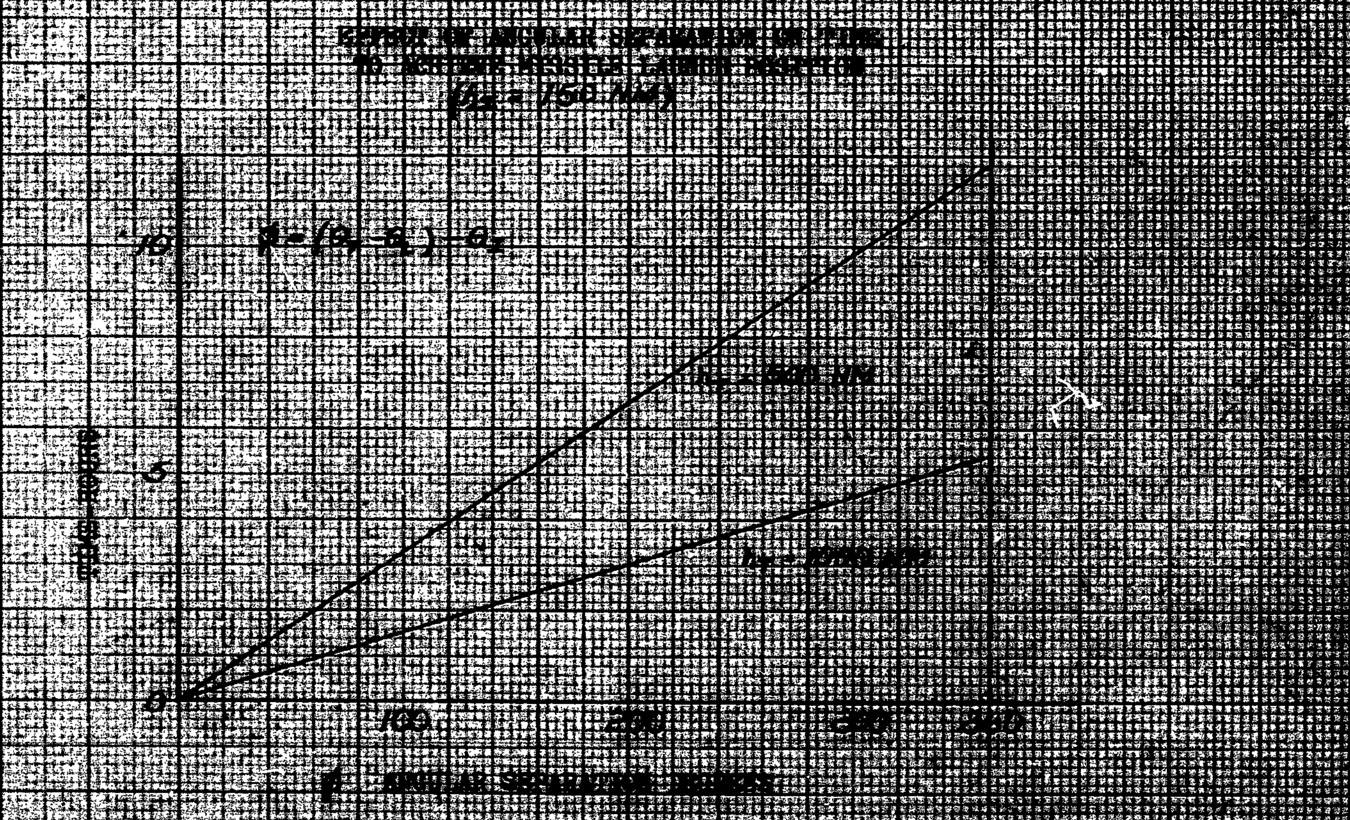
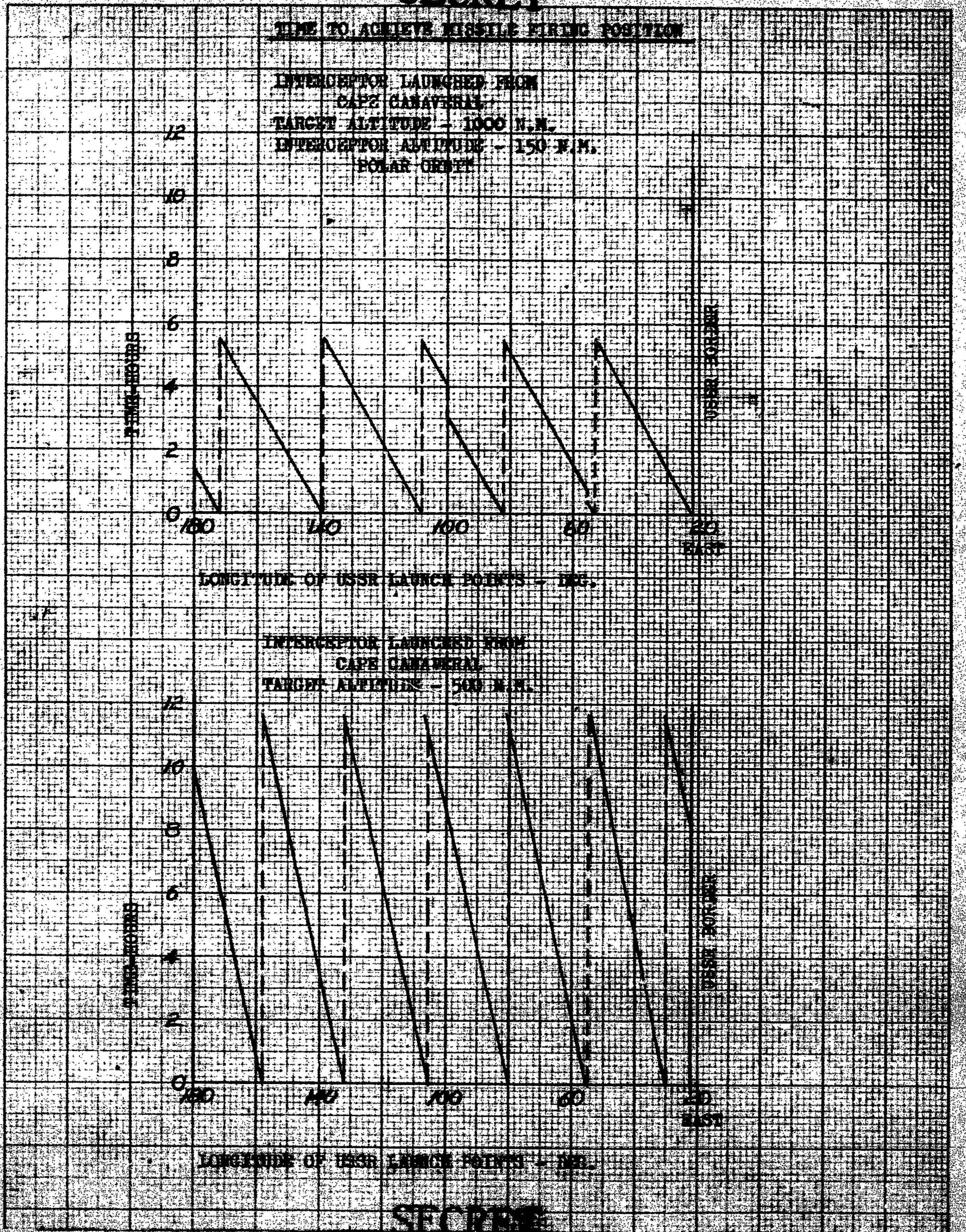
GENERAL ARRANGEMENT
ORBITAL INTERCEPTOR
FIGURE IVB-2

2

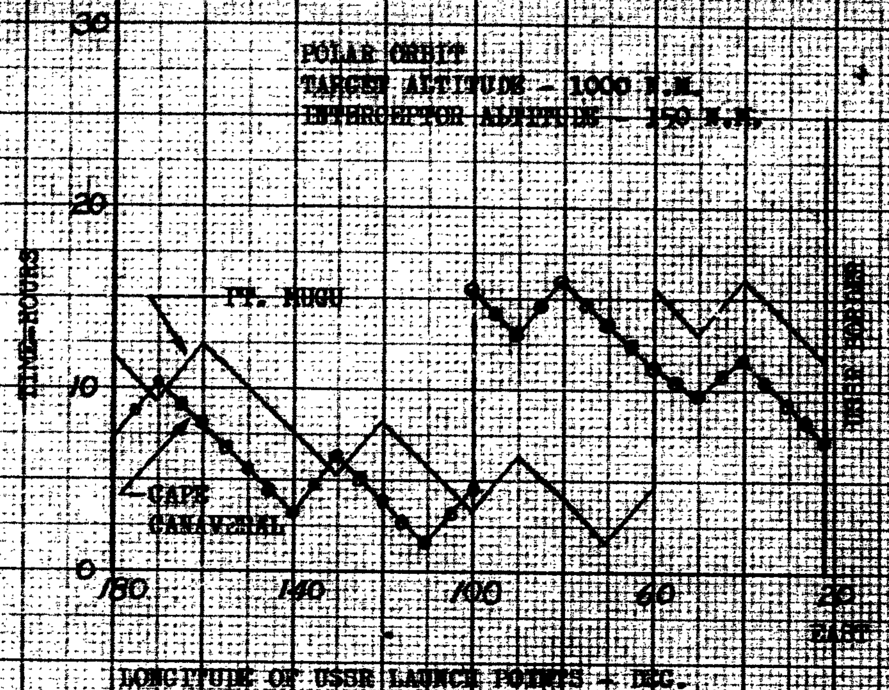

TIME TO REACH ORBITAL PLANE
POLAR ORBIT
TIME-HOURS
12
10
8
6
4
2
0
PT. MUGU
CAPE
CANAVERAL
180
140
100
60
20
EAST
LONGITUDE OF USSR LAUNCH POINTS - DEG.
USSR BORDER

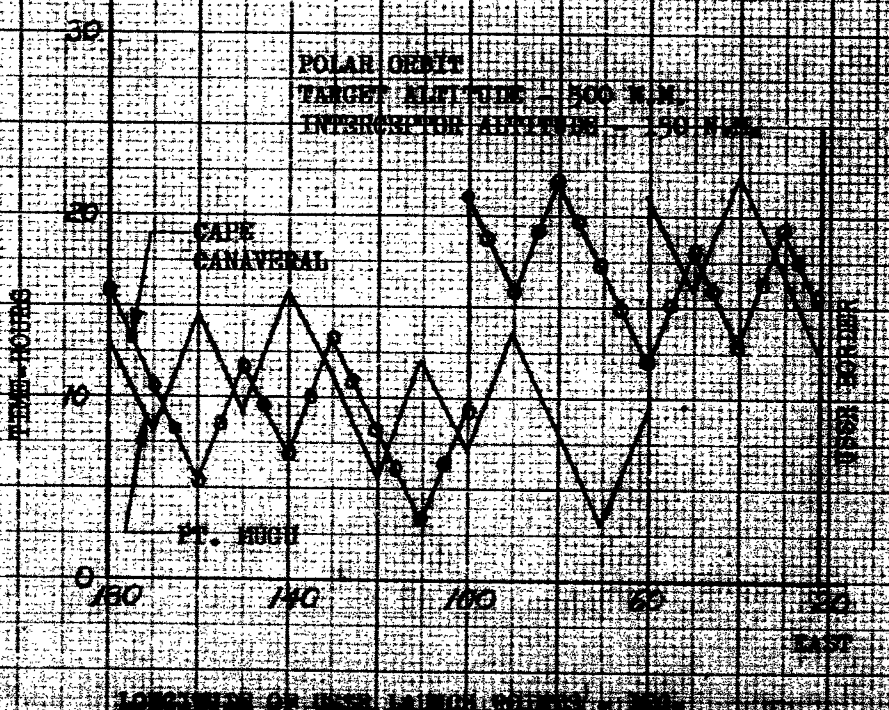

(h_T = 150 NM)
1000
800
600
400
200
0
0
10
20
30
40
50
60


10
5
0
100
200
300
360


TIME TO ACHIEVE MISSILE FIRING POSITION
INTERCEPTOR LAUNCHED FROM
CAPE CANAVERAL
TARGET ALTITUDE - 1000 N.M.
INTERCEPTOR ALTITUDE - 150 N.M.
POLAR ORBIT
TIME HOURS
USSR BORDER
12
10
8
6
4
2
0
180
140
100
60
20
EAST
LONGITUDE OF USSR LAUNCH POINTS - DEG.
INTERCEPTOR LAUNCHED FROM
CAPE CANAVERAL
TARGET ALTITUDE - 500 N.M.
TIME HOURS
USSR BORDER
12
10
8
6
4
2
0
180
140
100
60
20
EAST
LONGITUDE OF USSR LAUNCH POINTS - DEG.

TOTAL TIME TO INTERCEPTION





IV. MULTI-ORBIT WEAPON

G. ONE-WEEK ORBITAL BOMB, UNMANNED

1. Operational Concept

The One-Week Orbital Bomb Weapon System is the space age equivalent of the naval fleet which has been used throughout history to "show the flag" during periods of international crisis. In this concept a force of unmanned orbital warhead vehicles is deployed when war appears imminent. The vehicles remain aloft during the subsequent crucial hours or days, ready to strike enemy targets or land harmlessly at our own bases, as directed by ground command. As a dramatic accompaniment to a world-wide public announcement which presents the USA's position in the crisis, this weapon system demonstrates visibly to aggressor, neutral and friendly nations alike the firmness of our nation's stand and our readiness for action should war ensue.

The force of 100 vehicles is launched in groups of 25; only as many groups are launched as the situation and subsequent events require. Launching can begin within a few hours after the decision has been made. The entire force can be committed within an additional few hours, thus achieving maximum psychological effect.

Vehicles are placed into 300 mile altitude polar or near-polar orbits. This gives the maximum overflight of U.S.S.R. territory and insures that the enemy has full awareness of our striking force. Specialized decoys for the in-orbit

and reentry phases of flight are launched with the warhead vehicles to complicate the defense problem confronting the U.S.S.R. Nominal mission duration is one week; system design is based on a maximum flight time of two weeks to achieve this objective with a high degree of reliability.

Upon ground command to attack, the bombs reenter the atmosphere and proceed to their targets, following a glide trajectory similar to that of the ICGM. The 600 lbs warheads are delivered within a 1350 foot CEP. Should attack prove unnecessary, the gliders return to their bases in the USA where vehicle and associated ground equipment effect automatic landing. Decoys are not recovered. Gliders are decontaminated, processed through an inspection and overhaul facility and returned to the ready force.

2. System Configuration

The One-Week Orbital Bomb is a winged glider equipped with retro-rocket, warhead, inertial plus map matching bomb-navigation system, narrow band data link, environmental control system, flight controls, automatic landing system, and secondary power. It is similar to the One-Year Orbital Bomb (IV-B) in size, weight, configuration and equipment, with a few exceptions. All secondary power is provided by a liquid hydrogen - oxygen fuel auxiliary power unit. This eliminates the hydrazine - fuel power unit and solar cells. The glider fuel capacity limits maximum mission length to two weeks. This relatively short mission time (compared to

one year) relaxes in in-orbit reliability requirement significantly and reduces system development time accordingly. The short mission time is responsible for elimination of the particle shield. Probability of a vehicle - particle collision in one week of flight is so low that the shield is not justified. Short mission time also raises the possibility of omitting the in-orbit checkout provisions specified for the One-Year Bomb, a step toward simplicity.

Booster System

The booster for this vehicle is composed of four stages of advanced solid propellant rocket motors with one motor in each stage as shown in figure IV.G.1. (See Section V for more information on boosters). The booster is sized to place an 8,300 pound glider (including decoys) in a 300 N.M. circular polar orbit. The first and second stage motors would be poured, assembled and inspected at or near the launch site.

Weight Statement

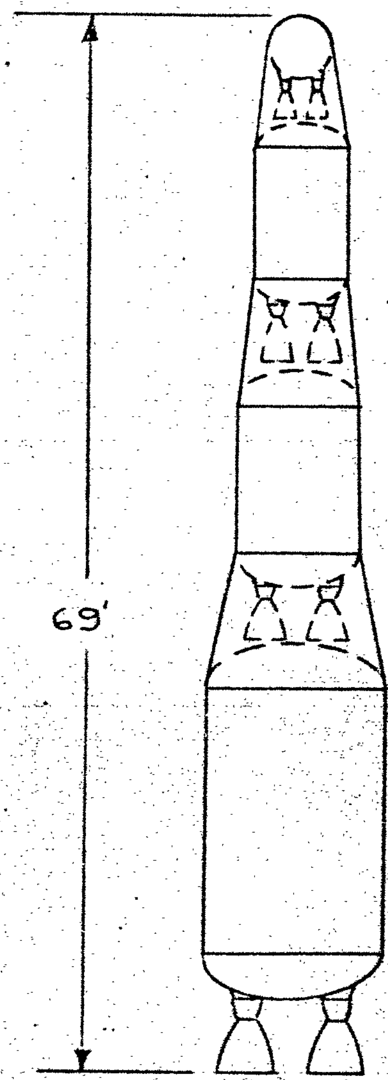
	Weight - Pounds
<u>Glider</u>	8,300
<u>Fourth Stage</u>	
Burnout	8,700
Propellant	4,000
Start Burning	12,700
<u>Third Stage</u>	
Burnout	15,000
Propellant	30,000
Start Burning	45,000
<u>Second Stage</u>	
Burnout	48,300
Propellant	60,000
Start Burning	108,800

<u>First Stage</u>

Burnout	122,800
Propellant	220,000
Launch Weight	342,800

PRELIMINARY WEIGHT STATEMENT: ORBITAL BOMB PLUS DECOYS

Item	Weight - Pounds	
Wing	596	
Body	1420	
Fins	310	
Control Surfaces	290	
TOTAL STRUCTURE		2620
Retro Rockets	560	
Vernier Rockets	240	
TOTAL PROPULSION		800
Auxiliary Power System (Including 180 lb. fuel)	360	
Reaction Control System (Including 15 lb. fuel)	80	
Hydraulic System	70	
Electric System	210	
TOTAL SECONDARY POWER		720
ENVIRONMENT CONTROL (Including 115 lb. expendables)		555
ELECTRONICS		1040
FLIGHT CONTROLS & MECHANISMS		140
LANDING GEAR		280
WARHEAD CONTROL		45
WARHEAD		600
BOMB GROSS WEIGHT		6300
RE-ENTRY DECOYS (2) (See Page IVB-7)		1100
ORBITAL DECOYS (2)		400
TOTAL GROSS WEIGHT		8300



BOOSTER FOR
ORBITAL BOMB - 1 WEEK, UNMANNED

Figure IV G-1

3. <u>Ground System and Support</u>

The ground system required to support the One-Week Orbital Bomb has not been investigated, but a few preliminary observations are presented for consideration.

An assembly and maintenance concept similar to that described for the fixed base ICGM (III-A) is applicable to this weapon system.

One launch site per ready missile plus additional sites for missiles undergoing erection or maintenance are required. Since there is no requirement for launch site hardness, a blast safety distance of 1300 feet determines the launch site spacing. Minimum total launch site area is approximately nine square miles for the force of 100 missiles. Additional area is required to protect surrounding installations and inhabited areas. Launchers at ground level and quick-opening shelters are suitable for this weapon system.

Erection equipment must be closely integrated with missile shipping, storing and handling equipment. Due to the relatively close spacing of the launch sites, erection equipment which moves from one site to another appears desirable and feasible.

Complex ground based automatic landing equipment, special servicing facilities and trained personnel are required to effect glider recovery; hence, cost limits the number of runways which can be provided. It is desirable to recover gliders at their launch bases to avoid shipping problems and

costs. Since all flights are in polar or near polar orbits, the maximum interval between USA landing opportunities for any one glider is only six hours approximately. Thus landing requirements can be met satisfactorily with only a few landing sites.

IV. MULTI-ORBIT WEAPONS

H. ORBITAL UNMANNED RECONNAISSANCE SYSTEM

1. Operational Concept

The object of this system is to obtain missile attack warning, photographic and infra-red mapping, and electronic intelligence of enemy territory. An unmanned system is used to obtain the reconnaissance data since the vehicles are subject to direct retaliatory measures.

Continuous infra-red missile detection coverage and complete, but not continuous, photographic coverage, IR mapping and Elint coverage is provided over Russia. Nine vehicles flying at 200 nautical miles altitude are dispensed in each of three equally spaced orbits inclined 75° to the equator.

Because cloud cover degrades the effectiveness of both photo and IR mapping procedures, the inclusion of radar would, at first, appear desireable. However, radar emissions permit the enemy to locate the operational vehicles and to discriminate against decoys. This disadvantage coupled with the low resolution obtainable with radar (20 - 50 feet) makes the value of radar questionable.

The vehicle shown in Figure IV.H.1 is similar to the manned vehicle described in Section III.B. By eliminating the pilot and his equipment, larger quantities of secondary power fuel, and equipment compartment pressurizing gas can be carried. This permits the vehicle to operate for 14 day periods. Normal orbital decay will not result in re-entry in the 14 day time period (See Figure X.A.1 Section X). Therefore

retro rockets are provided which permit re-entry to be commanded at any time.

One of the biggest problems with an unmanned system is to determine the type of data link to be used. The sensors have the ability to obtain much more data than can be transmitted back over a wide band data link on any pass over a ground station (See Section VI on Reconnaissance). Alternatives are to locate ground stations over a wide area or provide for data relay between reconnaissance vehicles. The first alternative exposes the ground portion of the data link to enemy overt or political action. The second increases the capability for enemy detection and enemy countermeasure and increases the size of the vehicle since relay equipment must be carried and greater secondary power energy is required.

Alternatives to transmitting all data back by data link are to provide a man in the vehicles to filter out data of little value, or to store the data until it is returned at the end of the mission. The storing of data until the vehicle returned degrades the value as operational data.

For missile warning purposes, a communication system is required which cannot be readily monitored or jammed. Since relays in the communication system are undesirable, a long range narrow band data link will be used. The data transmission may be minimized by limiting the reporting of missile firings until they reach a high density. However, this may result in loss of warning time.

Figure 1, Section IX tabulates some of the characteristics and capabilities of the WS-117L, a ballistic manned reconnaissance vehicle, and a hypersonic glide reconnaissance vehicle.

A comparison of the unmanned hypersonic glide system directly with the WS 117L can be made:

1. The glide vehicle provides greater military operational flexibility.
2. The glide vehicle provides for co-operational use of reconnaissance sensors. This provision is not in the present WS 117L program.
3. The WS 117L will be operational 3 to 4 years before the unmanned glide type system can be made operational and its ground communication and recovery complex is already being implemented.

The Unmanned Orbital Reconnaissance System does not appear to have sufficient advantages over either the WS 117L or the Manned Orbital Reconnaissance System to justify development.

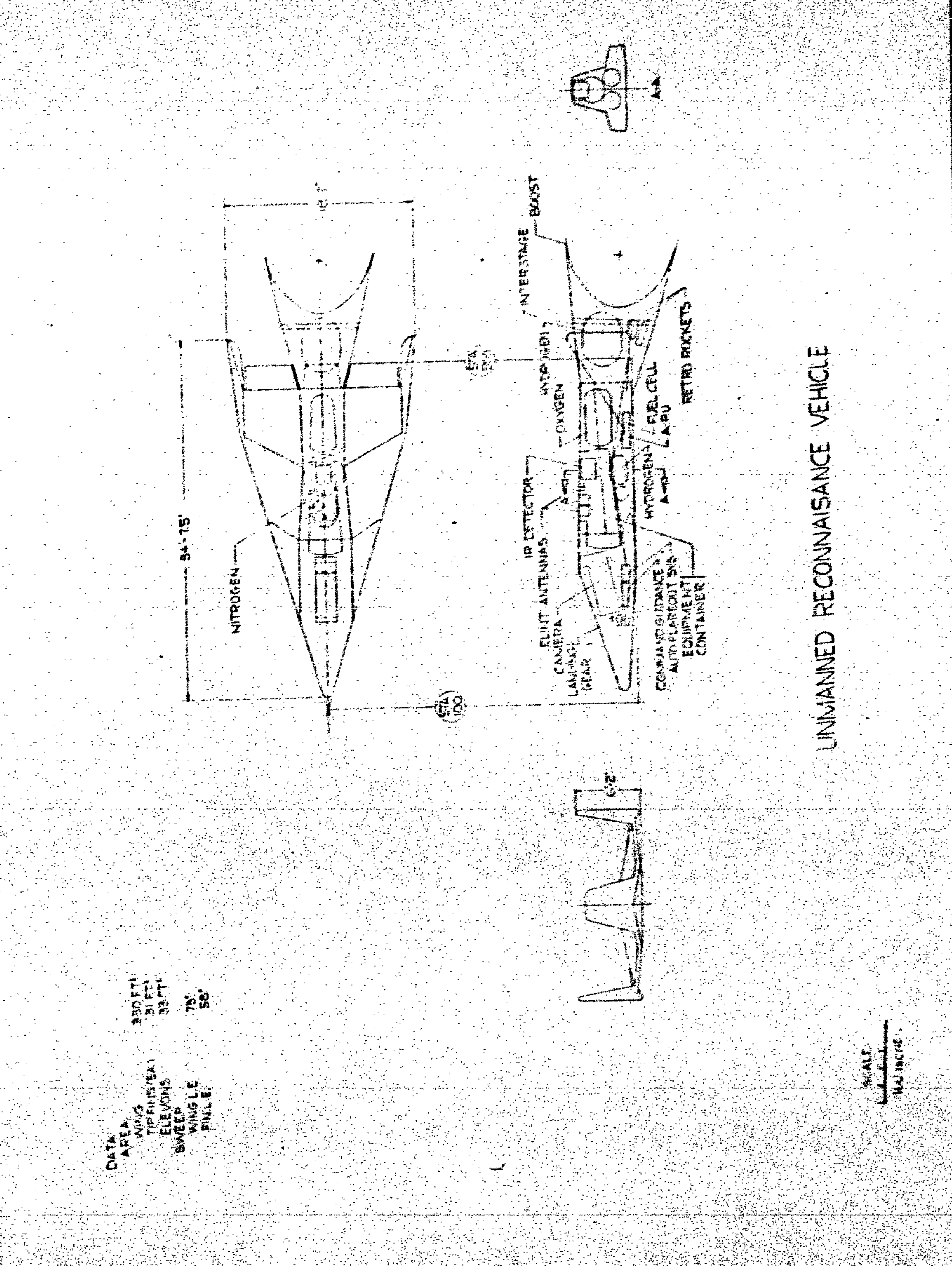

UNMANNED RECONNAISANCE VEHICLE
NITROGEN
54'-7.5"
INTERSTAGE
BOOST
HYDROGEN
OXYGEN
FUEL CELL
A.P.U.
RETRO ROCKETS
IR DETECTOR
ELINT ANTENNAS
CAMERA
LANDING GEAR
COMMAND GUIDANCE & AUTO FLAREOUT SYS
EQUIPMENT CONTAINER
STA 100
A-A
DATA
AREA
WING 330 FT²
TIP FINS (EA) 31 FT²
ELEVONS 33 FT²
SWEEP
WING L.E. 75°
FIN L.E. 58°
SCALE

Figure IV E 1

3. Ground System and Support

The unmanned reconnaissance system described in the foregoing sections consists essentially of gliders and boosters similar to those in Concept III B, plus ground communications stations. Ground system planning is based on the following operational requirements:

Utilization:

Twenty-seven gliders are in orbit at all times. Mission duration is approximately fourteen days each.

Number of Bases:

Two.

Launch Rate:

Two per day average (one per base). Capability for launching one additional vehicle per day for five days is required at each base.

Reaction Time:

Time of firing will be announced at least one day before launch.

Launch Site Hardening:

Not required.

Recycle Time:

Gliders two weeks; first stage booster one week.

These operational requirements are identical with those of the manned orbital reconnaissance system, Section IV - A. Base organization and facilities can be similar and would include ready vehicle storage; launch sites; landing runway with automatic landing control system; post-flight servicing facilities; base industrial area incorporating a vehicle assembly, maintenance and test (A & T) facility; HQ area including administration, communications and training; necessary base housekeeping and personnel quarters. Second stage processing in the A & T facility can be simpler for the unmanned vehicle. The smaller unit used can be fully built-up by the manufacturer prior to shipment. Glider maintenance and servicing facility requirements do not scale down in direct proportion to size because of the large number of sensors and associated data reduction and transmission systems.

Fundamental quantitative requirements for the system as a whole are presented below. These quantities include no provisions for losses, failures or aborts.

Force Size:

Gliders	64
First Stage Boosters	24

Annual Replacements: (based on useful life)

Gliders	24
Second Stage Boosters	730
First Stage Boosters	0.2
Launch Sites: (4 per base)	8

Personnel:

Flight	8
Ground-Direct & Supervision	4000 - 5000

IV. MULTI-ORBIT WEAPONS

J. ORBITAL BALLISTIC MISSILE INTERCEPTOR

1. Operational Concept

Both Manned and Unmanned Orbital Ballistic Missile Interceptors have been considered. The purpose of these interceptors is to destroy ballistic missiles as far from United States territory as possible. Many of the operational procedures and the problems encountered are common to both manned and unmanned systems.

The interceptor vehicles are placed in polar orbits in order that they will have global coverage and be able to intercept intermediate range as well as intercontinental range ballistic missiles.

The intelligence for these systems is derived from data gathered by orbital ballistic missile detection and tracking systems such as the one described in Section VI, supplemented by ground based missile detection and tracking systems such as the Ballistic Missile Early Warning System. The tracking data is processed through a Data Processing Center, interceptor vehicles are selected and ordered to the attack. As an alternate means of control, the manned system can gather data, derive intelligence on which to act while in-orbit, and commit interceptor vehicles from the manned orbital vehicle itself.

The use of winged vehicles for these missions permits return of the vehicles to base for maintenance, repair and

in the case of the manned systems, rotation of the crew members.

The crew is a very vulnerable link in the manned system. The crewmen will be endangered both by enemy defense systems and by radiation created by their own warheads. It is not considered likely that many would survive a battle.

One of the problems in both the manned and unmanned systems is that of bringing to bear on the ICBM warheads a sufficient number of defensive warheads to destroy the threat. For example, consider a system which has 16 vehicles per orbit plane in 25 polar orbits. In this deployment, eight vehicles approach Russia from the south and eight from the north. However, of the eight vehicles approaching from the south, only one can be used to intercept ICBM's launched at random. Of the vehicles approaching from the north, five may make an interception. The system efficiency is 6/16 or approximately thirty-eight percent for the interceptor with a single weapon. Against low angle trajectories, the efficiency can be as low as 19%.

The data links in these systems are very vulnerable to jamming, particularly, in the unmanned system. The manned system, with its capability of generating commands can have more secure communications than the unmanned system.

Because of the ease in which these systems can be saturated unless large numbers of interceptors are used, the vulnerability of the man, and the ease with which the com-

munication links can be jammed, the Orbital Ballistic Missile Interceptor systems are not considered promising.

IV. MULTI-ORBIT WEAPONS

K. MANNED ORBITAL BOMBER

1. Operational Concept

The Manned Orbital Bomber provides to the United States Military establishment a minimum vulnerability weapon system capable of maintaining continuous alert. In event of hostilities, the glide bombs are armed and launched against selected enemy targets. The lateral maneuver capability of the glide bombs (3000 nautical miles) permits strikes against targets spread over a large geographical area. The bombers are spaced in random orbits inclined 30° to the equator permitting 30 to 40% of the bombs to be activated and directed against targets in a few minutes. Some missions may be launched in polar orbits in order to overfly the U.S.S.R.

The Manned Orbital Bomber carries a three man crew and eight glide bombs equipped with nuclear warheads. The bomber remains in orbit for a two week missionperiod. At the end of the mission period the bomber releases and de-orbits its bombs, which are then landed separately through a ground control system. The manned vehicle then deorbits and maneuvers to a selected landing location. The selection of random orbits inclined at 30° to the equator makes enemy offensive action slower and more costly. Several kinds of attacks can be launched against the orbital bomber, including attack upon launching bases, direct attack on the vehicle from the ground based weapons, attacks by means of radiation trapped in

the earth's magnetic field, and attacks by orbital interceptors. Once in orbit the bomber is safe from attacks on the launching sites. Decoys will make direct attack on the bombers by either ground based or orbiting interceptors difficult and costly. The decoys used will require stabilization and must simulate most of the detectable characteristics of the bomber. The bomber altitude will be kept as low as possible in order to avoid any radiation resulting from electrons trapped in the earth's magnetic field.

The 30° orbital path skirts the southern borders of the USSR without overflying that country. With the maneuver capability of the glide bombs, targets at 80° north latitude can be reached from a bomber position at 30° north latitude.

Missions launched into polar orbits have the advantage of much greater strike potential, see Figure IV.K.1, although the enemy counter measure potential is much greater. In these orbits the bomber crew can provide reconnaissance information such as target locations, weather reconnaissance, monitoring the enemy communication system, and monitoring radiation levels.

A three man crew will be used on the Orbital Bomber to permit a fourteen day mission, assuming a four hour "on" -8 hour "off" duty cycle. The crew of the Orbital Bomber adds a positive element of control to the weapon system. Arming of the glide bombs is initiated by the man. Until these manual operations are performed, the bombs remain unarmed, and the

danger of inadvertant detonation of warheads is virtually eliminated. In orbital operation, the crew makes up-to-date target/bomb designations and performs other subsystem operational functions. The reliability of the entire system in orbit is increased by the human capabilities of a crew to monitor malfunctioning equipment and replace component parts.

The number of glide bombs carried by the Orbital Bomber is a compromise between several conflicting requirements. As the number of bombs per bomber is increased, the vulnerability of the entire weapon system goes up because each successful enemy attack on any one bomber eliminates a higher percentage of the total number of bombs. Conversely, as the number of bombs per bomber is decreased, the number of vehicles, personnel, and support elements is increased to maintain the same offensive capability for the continuous alert. Also, the bomb packaging versus structural size and weight must be considered for a launching configuration. The optimum bomb load per bomber must also consider an estimate of the USSR defensive system and the utilization of these systems. A load of eight bombs was chosen for this vehicle as a reasonable compromise among the above factors.

A force of 63 bombers with eight glide bombs per bomber is required in continuous orbit to provide the offensive capability needed to destroy 300 target sites.

Figure IV.K.2 shows the mean reaction time for a system of

bombers in which 20% are equally spaced in polar orbits and 80% are equally spaced in orbits inclined 30° to the equator. Actual reaction times may vary from those shown due to a dependancy on the factors enumerated above.

Upon an attack decision, the nuclear warhead arming sequence is initiated by a bomber crewman. Thereafter, at a precomputed position the bomb is released from the bomber and its de-orbiting retro rocket fired. The bomb then follows a programmed flight path to a geographical reference point, with midcourse guidance provided by a self-contained, inertial guidance system. Terminal guidance consists of radar map-matching corrections to the inertial guidance system, by fixes taken on the reference point and the target. A CEP of 1,350 feet can be achieved.

When a return-to-base decision is made, the bomb is released from the bomber, in an unarmed condition, at a precomputed position. The remainder of the flight to the earth's furface is identical to the attack phase except that additional maneuvers may be performed to decelerate to landing velocitites, a landing gear is deployed, and the bomb lands at prepared landing installations. The glide bomb is then inspected, repaired as required, and re-used on later bombing missions.

The unused glide bombs are landing in the U.S. separately from the bomber. Since the glide bomb is necessarily a re-entry configuration with self-guidance and control, it is

illogical to provide extra structure weight in the bomber to carry the bombs within the bomber during landings.

Consideration has been given to leaving the bombs in orbit. By properly integrating the bombs to the orbiting canister, servicing can be performed in orbit. Thus only the malfunctioning parts need be returned to base, thus eliminating the landing requirement on the bombs. The bombs are always in readiness since a replacement bomber can rendezvous before the other leaves. If a satisfactory decoy solution can be found, a system of permanent orbiting bombs should be studied as a possible improvement to the system presented.

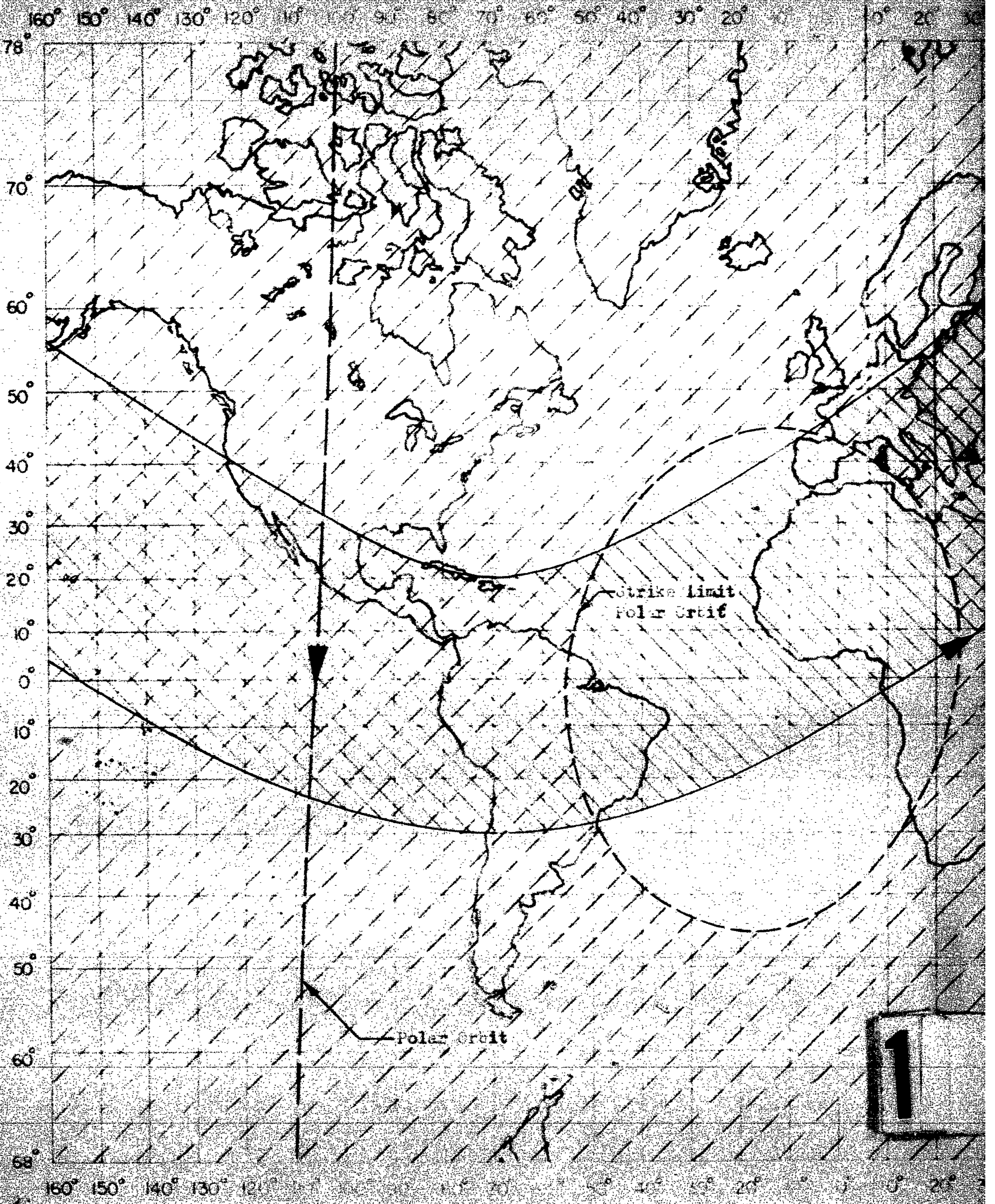
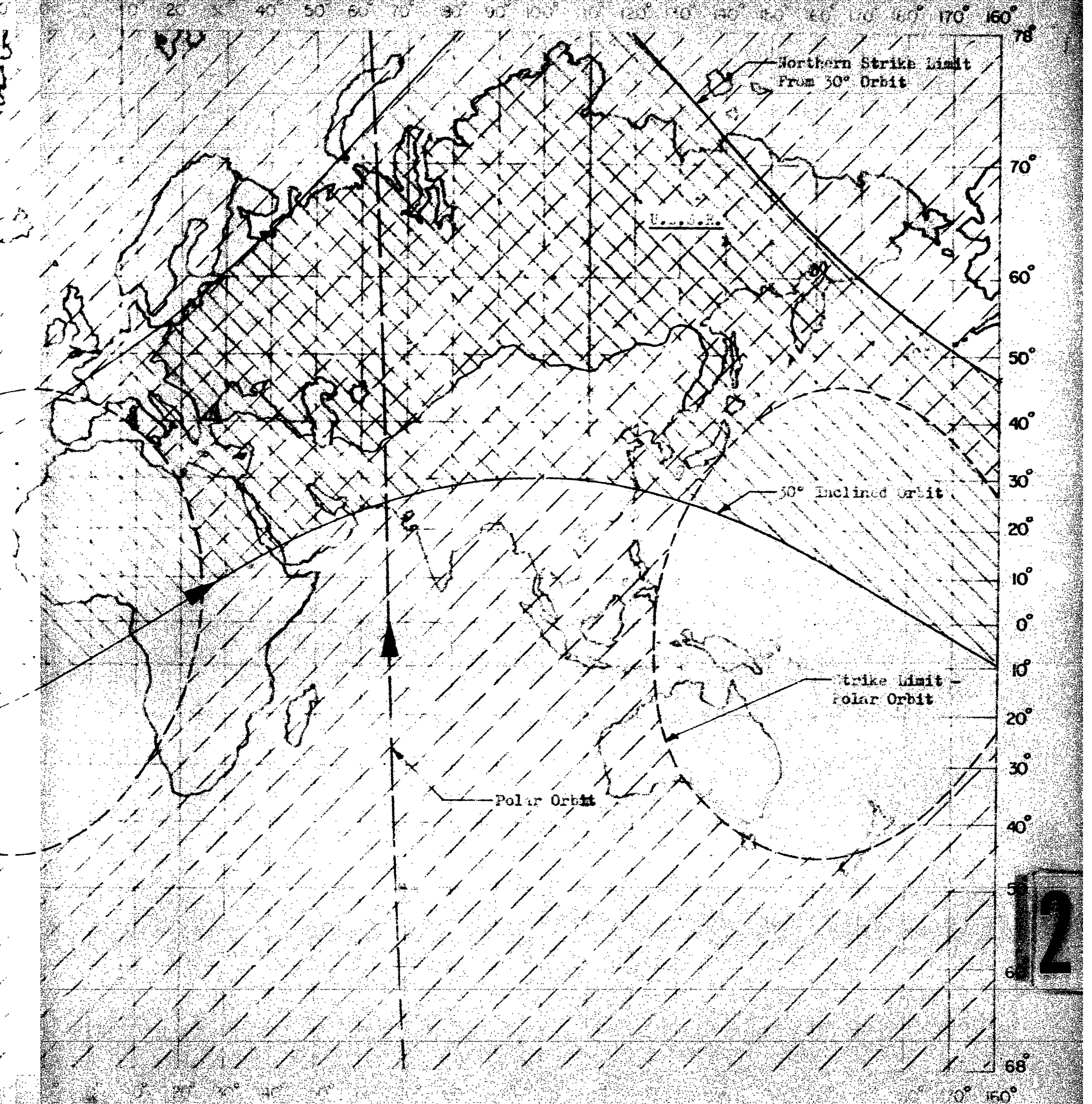


FIGURE IV.K. 1



Northern Strike Limit
From 30° Orbit
U.S.S.R.
30° Inclined Orbit
Strike Limit –
Polar Orbit
Polar Orbit
70°
60°
50°
40°
30°
20°
10°
0°
10°
20°
30°
40°
68°

FIGURE IV.K. 1

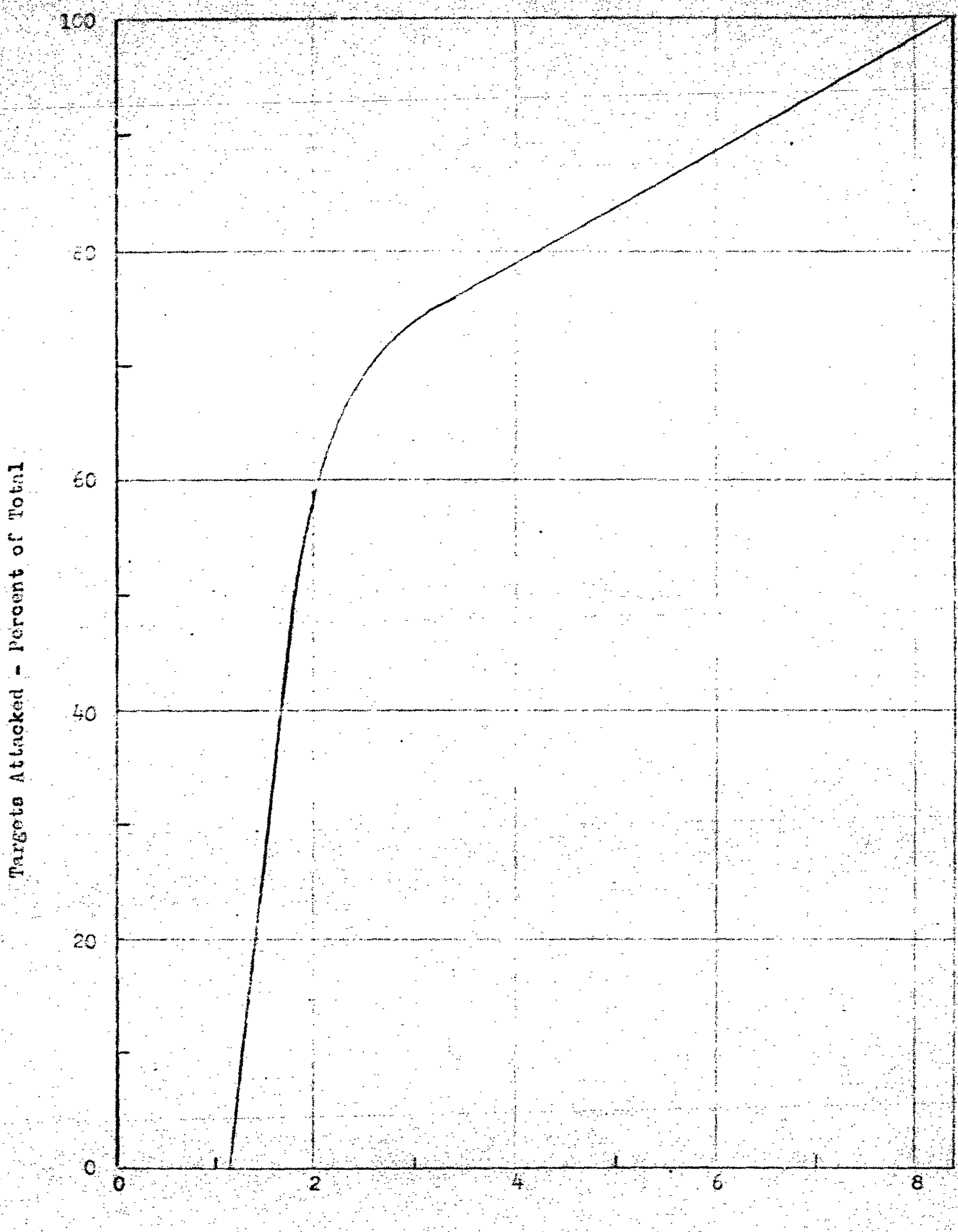

100
80
60
40
20
0
0
2
4
6
8
Targets Attacked - Percent of Total
Elapsed Time From Attack Command - Hours

Figure IV.K.2

2. Performance and Configuration

The Manned Orbital Bomber system is composed of a manned glide re-entry bomber vehicle with an attached interstage unit, eight glide bombs, a booster subsystem composed of a manned recoverable first stage and a non-recoverable second stage, and system support elements.

The bomber vehicle, with attached interstage unit, is launched into a 125 nautical mile altitude orbit by the booster subsystem. The bomber, manned by a crew of three remains in orbit for a period up to 14 days. Upon receipt of "Strike" command, the bomber launches its glide bombs against preselected targets. At the end of a non-eventfull mission the bomber returns to base. However, it first launches its bombs, which land separately guided by automatic landing components. After bomb launch the deorbiting retro-rockets are fired and the interstage structure is released. The glider re-enters and effects a landing at a pre-selected landing field. Throughout the entire mission it is possible for the crewmen to escape from the bomber by means of an escape capsule.

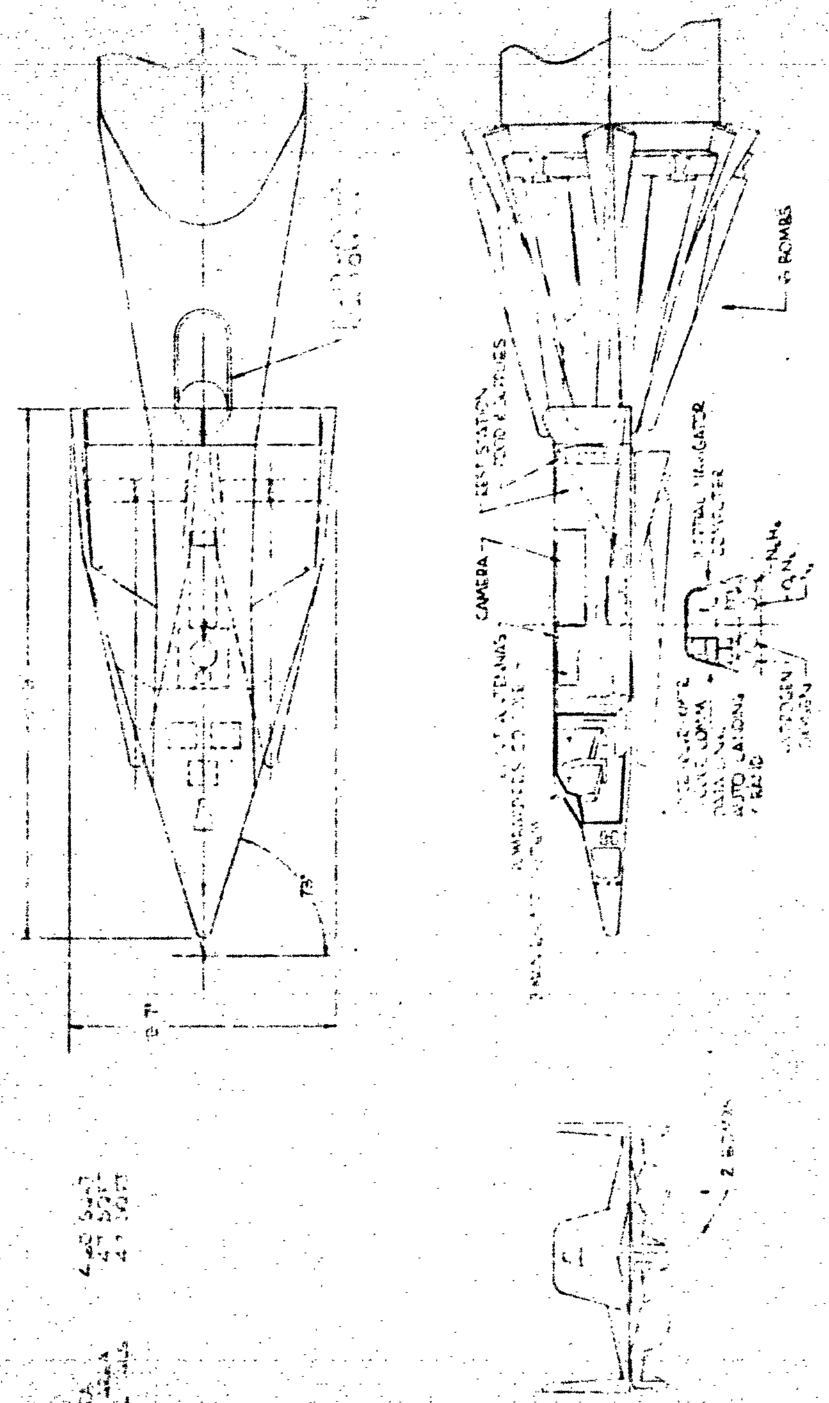
The orbital life period of two weeks, without reboost provisions, determines that 125 nautical miles altitude be the minimum circular orbit altitude. In a 125 nautical mile circular orbit the orbital velocity is 25,510 feet per second and the orbit period is 89 minutes. Optimization of range-power requirements indicates that a deorbiting velocity increment equal to 700 feet per second be employed by both the bomber and the bombs. A ΔV=700 feet per second will cause re-entry into the atmosphere at 3,200 nautical miles range from retro-rocket firing position; and, landing is

251c

achieved at a maximum of 7,500 nautical miles range from the firing position. After re-entry, both the bomber and bombs can maneuver laterally, from the orbital plane, to a maximum of 3,000 nautical mile range.

The manned bomber vehicle is a DS-I type glide re-entry configuration, see Figure IV.K.3. Accommodations and supplies for three crewmen are provided, for a 14-day bomber mission. The three crewmen are accommodated in a separable escape capsule during launching, re-entry and landing phases of the mission. A bombardier station is provided in the bomber mid-section for use by one crewman during the attack portion of the mission. A 3 foot resolution reconnaissance camera and ELINT reconnaissance sensors are mounted in the bomber midsection. Rest quarters are positioned in the aft compartment of the bomber.

Two glide bombs are shackled to the bomber vehicle's lower surface during launch and orbiting mission phases. The bomber interstage unit effectively increases the payload envelope of the bomber vehicle without undue increases in the re-entry vehicle size. Retro-rockets and secondary power fuel supply are contained within the interstage structure, while six glide bombs are clustered around the exterior. After release of the glide bombs, either for landing or attack, and the expenditure of the fuel supply, the retro-rockets are fired and the interstage unit is released from the bomber vehicle.



ORBITAL BOMBER

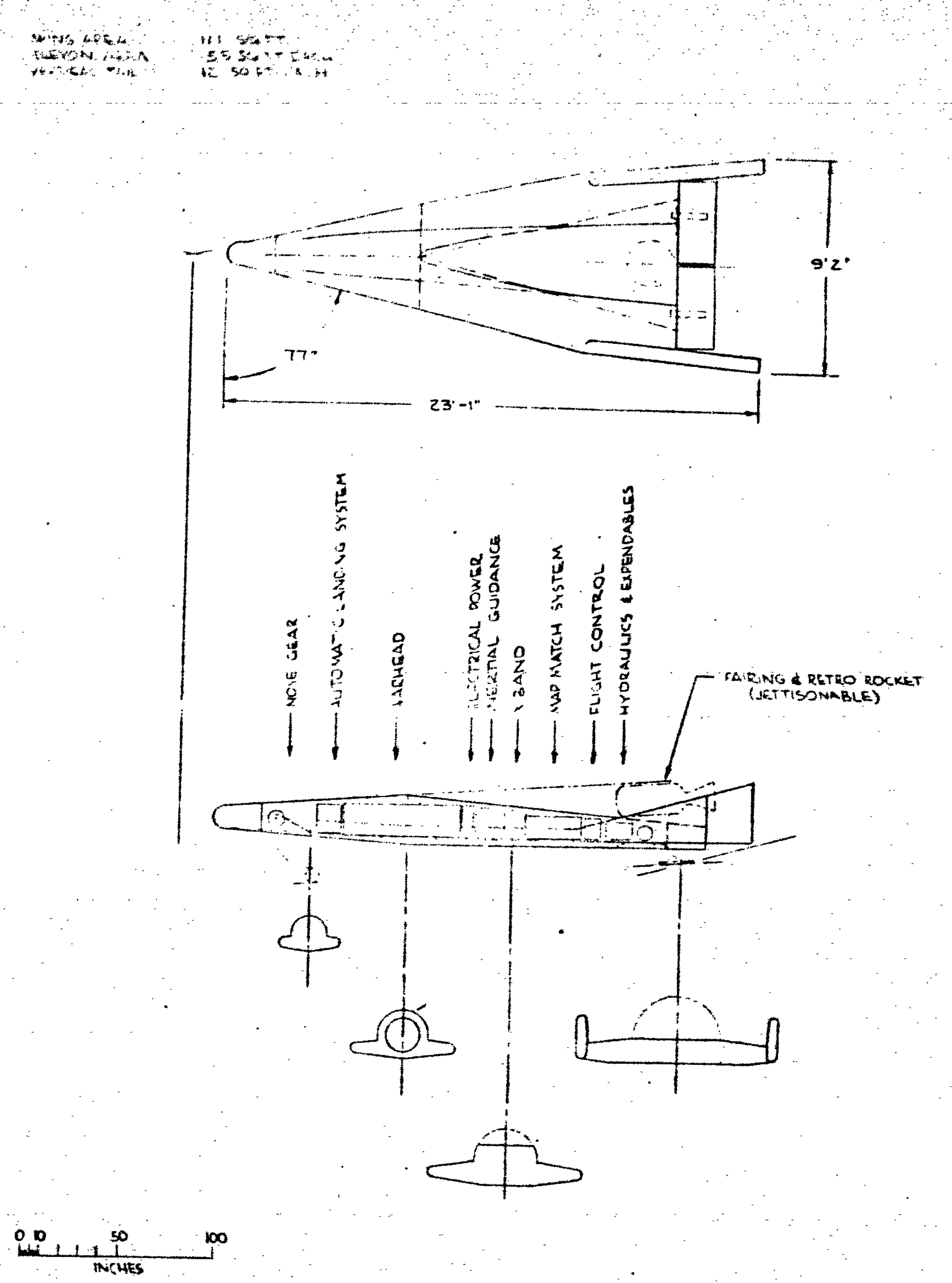
FIGURE IV.K. 3

Glide Bomb

Upon receipt of "strike" command, the glide bomb is armed, by a bomber crewman, and launched to strike a pre-selected target. A de-orbit retro-rocket, imparting a ΔV=700 feet per second, is fired to decelerate the bomb from orbital velocities. At 3,200 nautical miles range, from retrorocket firing postion, the bomb re-enters the atmosphere. After re-entry the bomb begins a programmed gliding turn towards the target. A C.E.P. = 1,350 feet can be achieved utilizing radar map matching equipment. Targets positioned 3,000 nautical miles, or less, range normal to the bombers orbital plane can be attacked by the glide bomb.

If no command to attack is received by the bomber, the bomb can be safely landed at pre-selected sites within the United States zone of interior. The re-entry into the atmosphere is made in a manner identical to the attack phase, except that the bomb is unarmed. After re-entry, programmed maneuvers bring the bomb to the landing site at the correct landing speed. A landing gear is deployed and the bomb effects a normal airplane landing.

The external configuration of the bomb is similiar to the DC-I configuration, see Figure IV.K.4. A 600 pound nuclear warhead, an inertial guidance subsystem, a radar map-matching subsystem, an automatic landing subsystem, power supplies, control subsystems and a landing gear are packaged in the glider fuselage. The de-orbit retrorocket is mounted in a jettisonable fairing on the glider's upper surface.



ORBITAL BOMB

FIGURE IV.F. 4

Weight Data

Shown below are preliminary weight statements for the manned bomber and the bomb. The quantity of expendables in the bomber are sufficient to support the bomber for the maximum mission time of 14 days plus 1 day emergency. In addition electrical power is furnished by the bomber to each bomb for the purpose of maintaining the inertial guidance and other required systems in operation prior to bomb release.

Preliminary Weight Statement - Bomber:

Item	Weight - Pounds	
Wing	1,020	
Body	3,010	
Fins	480	
Control Surfaces	590	
TOTAL STRUCTURE		5,100
Orbit Injection and Retro Rockets	1,480	
Capsule Separation Rockets	300	
TOTAL PROPULSION		1,780
Auxiliary Power System (Incl. 70 lb. fuel)	620	
Reaction Control System (Incl. 100 lb. fuel)	300	
Hydraulic System	150	
Electric System	340	
SECONDARY POWER SYSTEM		1,410

ITEM	WEIGHT - POUNDS	
Capsule Environmental Control (Incl. 110 lb. expendables)	610	
Glider Environmental Control (Incl. 150 lb. expendables)	650	
TOTAL ENVIRONMENTAL CONTROL		1,260
ELECTRONICS		1,710
FLIGHT CONTROL & MECHANISMS		300
LANDING GEAR		380
CREW OPERATIONS (Incl. Crewmen)		1,600
TOTAL BOMBER		13,540
INTERSTAGE		1,400
APU FUEL SYSTEM (Incl. 2040 lb. fuel)		2,640
BOMBS (8) (For details, see below)		28,560
TOTAL "PAYLOAD"		46,140

Booster System

The booster for the Manned Orbital Bomber vehicle is a two stage booster. See Figure IV.K. 5. The first stage uses liquid oxygen and liquid hydrocarbon propellants and is recoverable. The second stage is expendable and goes into orbit with the glider. It uses liquid oxygen and liquid hydrogen propellants. (Section V contains more information on boosters).

The first stage attains a burnout velocity of 6,700 fps. The upper stage then has the capability of placing a 46,140 lb. payload in a circular, polar orbit with an altitude of 150 N.M.

Weight Statement:

	Weight-Pounds
Glider & Bombs	46,140
Second Stage	
Burnout	76,140
Propellant	272,000
Start Burning	348,140
First Stage	
Weight Empty	220,000
Pilot	250
Trapped Rocket Propellant	11,600
Turbojet Fuel	43,000
Propellant	1,160,000
Launch Weight	1,782,990

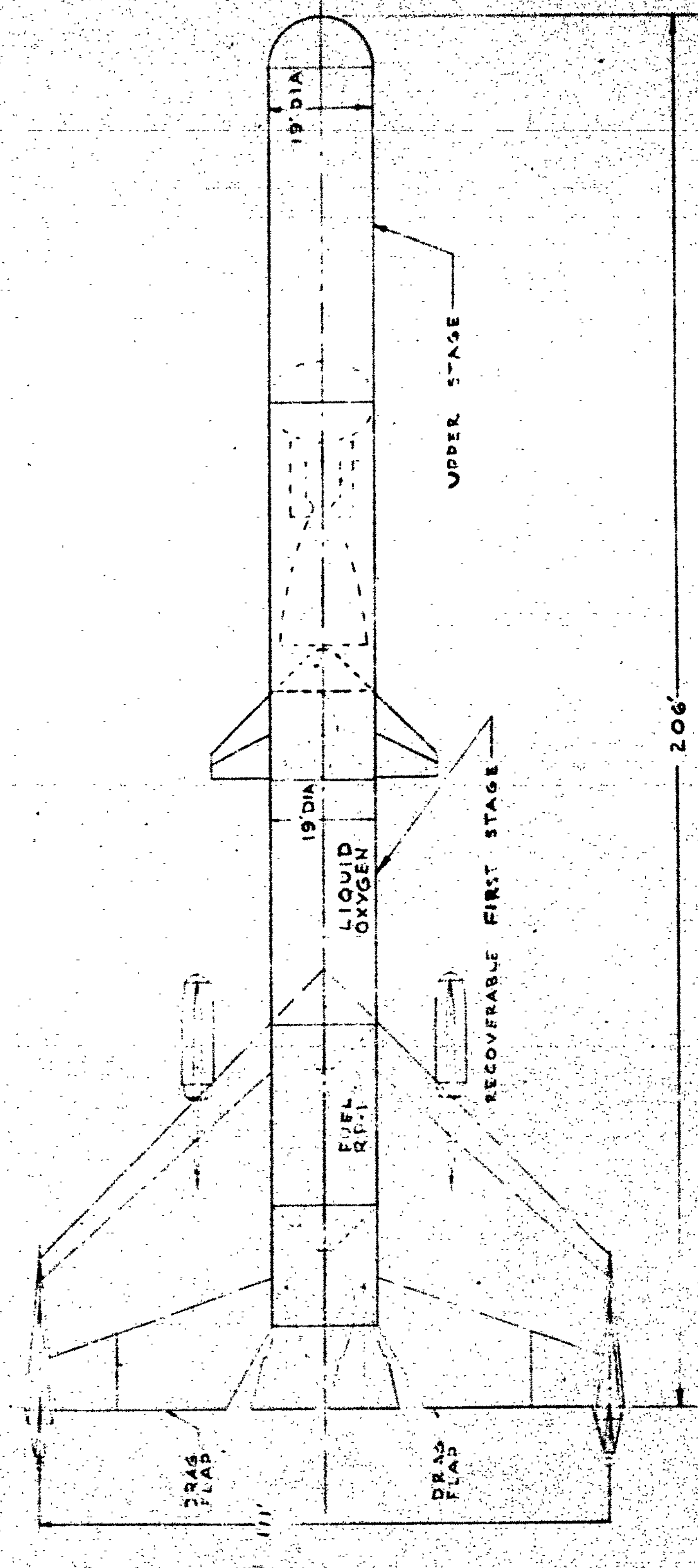

19' DIA
UPPER STAGE
206'
19' DIA
LIQUID OXYGEN
RECOVERABLE FIRST STAGE
FUEL RP-1
DRAG FLAP
DRAG FLAP

FIGURE IV.K.5

PRELIMINARY WEIGHT STATEMENT - BOMB:

ITEM	WEIGHT - POUNDS	
Wing	260	
Body	770	
Fins	120	
Control Surfaces	150	
TOTAL STRUCTURE		1,300
RETRO ROCKET INSTALLATION		360
Hydraulic System	60	
Electric System	230	
SECONDARY POWER SYSTEM		290
PRESSURIZATION & COOLING SYSTEM (Incl. 120 lb. expendables)		290
ELECTRONICS		500
FLIGHT CONTROLS & MECHANISMS		100
LANDING GEAR		90
WARHEAD CONTROL		40
WARHEAD		600
BOMB GROSS WEIGHT		3,570

3. Ground Systems and Support

Some idea of the magnitude of the ground system required to support the Manned Orbital Bomber Flight System can be gained from the following facts.

a. The flight article stands 215 ft. high at launch, it weighs 296,000 lbs. dry and 1,783,000 lbs. fully fuelled. Assembly in or erection to the vertical position is required.

b. At lift-off, the first and second stage boosters contain 25 tank car loads of liquid propellants, mostly cryogenics. Additional quantities are required to compensate for cool-down and boil-off.

c. 1683 successful launchings must occur each year (5.25 per day based on a six day work week). It follows that the same number of bomber and first stage booster landings must be accomplished during the same time period.

d. At the end of its tour of duty in orbit, the bomber must release its bombs. If these glide bombs are released simultaneously and are directed toward a single base, all eight bombs could come in for landing within a few seconds of one another.

e. Recoverable flight equipment must be tested and reconditioned after each mission. For the conditions assumed, 6 bombers, 48 glide bombs and 6 first stage boosters must be completed every working day.

Technical Considerations

One to six or more bases could be postulated and justified for this weapon system. Geography, economics, politics and technical

factors are involved. Eastward firing and base locations in Florida and/or southern Texas are two firm requirements established by the weapon deployment concept (low-angle orbits for most vehicles). Northward firing capability is required from at least one base; the polar orbit requirement imposes no geographical restriction on launch base location.

Useful life on the order of 30 flights for glide bombs and manned vehicles, and 250 flights for recoverable first stage boosters is postulated. Quick "turn-around" of these items is essential to minimize flight hardware quantities. High probability of successful launch (90% or better) is equally essential for system feasibility; this requires thorough testing and vehicle maintenance. The most promising approach for simultaneously attaining both objectives is by means of extensive test, repair and final assembly (A & T) facilities, integrated with the launch bases.

Under the A & T concept, glide bombs, bomber vehicles and first stage boosters recovered from previous flights are tested and refurhished as necessary on separate lines. Maintenance is accomplished on a remove-and-replace basis when this method minimizes vehicle time at any station. Malfunction isolation and repair of faulty components or subsystems removed from the major items are accomplished by the A & T or outside organizations, depending on the technical and economic considerations. Accepted recoverable flight equipment and any new major items required (2nd stage boosters, glide bombs, etc.) are moved to stage build-up areas. Stations are provided for bomber/interstage assembly and glide bomb mounting thereon. Booster section build-up is planned on similar principles,

reducing final assembly operations to the joining of three large elements - 1st stage, 2nd stage and payload. Final assembly and erection facilities are so costly that these operations are centralized in the A & T area to avoid the additional investment required for performing them at the launch sites. Due to the sizes and weights involved, vertical final assembly of the glider and booster is considered more practical than horizontal assembly and erection by means of a strongback. The vehicle is assembled in launch configuration on a large dolly equipped with railroad trucks per Figure IV.K.6. The dolly serves as a storage and launch fixture as well as for transportation. Twin railroad tracks and small switching locomotives facilitate movement to the storage and launch areas.

A centralized fueling installation might be more economical, but safety and storage problems require that fueling be performed at the launch sites. The large daily consumption of propellants makes cryogenics plant location on or adjacent to each base desirable. (Base locations in Texas would provide close proximity to sources of the natural gas required for liquid hydrogen manufacture). Pipelines to storage tanks at the individual launch pads might be more economical than tank car transportation of propellants.

Boil-off of cryogenics from uninsulated booster tanks is a serious problem. At 100° F. ambient, top-off requirements for this system's boosters would be on the order of one complete LOX change every 20 minutes and a liquid hydrogen change every two minutes. Refrigerated jackets and thin, light-weight insulation blankets

which can be removed just prior to launch are two approaches under investigation by the cryogenics industry. The wings on the 1st stage booster, and height of the second stage above the launch pad introduce complications, but either of these approaches for cryogenics conservation can be adapted to the launch configuration of the vehicle.

One 10,000 foot runway per base is adequate for landing of first stage boosters, manned bomber vehicles and cargo airplanes. This runway should be close to the base industrial area to minimize ground transportation requirements.

For the weapon system as a whole, the glide bomb landing system requiring minimum facilities would consist of one runway plus control and safety equipment at a single base. A potential traffic problem - eight bombs trying to land simultaneously - could result, since it is desirable that a bomber release all of its bombs at the same time (or nearly so), during its own preparations for re-entry. Investigation shows that, by taking advantage of the glide bomb energy management capability, vehicle arrivals can be spaced about two minutes apart. See Figure IV.K.7. Since the automatic landing sequence takes about four minutes, a minimum of two runways and two automatic landing systems are required to land each group of eight glide bombs. Development of time-sharing techniques would permit one automatic landing system to guide all incoming bombs, but prudence requires that additional installations be available to take over in event of a crash or ground equipment failure. Use of glide bomb landing strips is restricted to these vehicles. Strips should be close to main

bases, but this is not as important for glide bombs as it is for the manned flight equipment due to their relatively small size.

An extensive training program and organization are required, due to the large number of ground and flight personnel utilized in this weapon system. In contrast with the Piloted Hypersonic Boost Glide Bomber and similar "one-shot" systems however, periodic crew training flights are not required; the operational flights provide ample opportunity for maintenance of technical proficiency.

An analysis such as the foregoing by no means determines ground system design, but it does provide some basis for postulation of a ground operations plan. This in turn provides a rational basis for estimating facilities and personnel requirements as summarized below. The requirements listed are for a perfect system (no losses or aborts) and hence represent the minimums which actual systems might approach. Total quantities, production rates, etc. would be increased when the results of more detailed studies were available.

Ground System Data and Requirements

Required Weapon Deployment	63 bombers w/8 bombs each in random orbits at all times.
Recycle Time (Recovery thru Launch)	
Bombers	2 weeks
Glide bombs and 1st stage boosters	1 week
Launch Pad Time per Vehicle	24 hours
Force Size (No Allowance for Failures or Losses)	
Bombers	126

Glide Bombs	756
1st Stage boosters	32

Replacement Rates (Wearout Only; No Allowance for Failures or Losses)

Bombers (30 flights)	55/year
Glide bombs (30 flights)	437/year
1st stage boosters (250 flights)	6.5/year
2nd stage boosters (non-recoverable)	1638/year

Work Schedules

A & T	5 days; 16 hours
Launch pads and programmed recovery	6 days; 24 hours
Cryogenics production	Continuous
Emergency recoveries	Continuous

Production Rates Required (Net; No Allowance for Failures or Losses)

A & T	PER WEEK	PER DAY
Bomber overhaul	31	6.2
Glide bomb overhaul	244	48.8
1st Stage booster overhaul	32	6.4
Vehicle final assembly	32	6.4
Vehicle launchings	32	5.25
Landings and Recoveries		
Bombers and 1st stage boosters	32	5.25
Glide bombs	256	42,6

Propellants (No allowance for Boil-Off)	TONS/DAY
RP - 1	980
Liquid oxygen	2850

	TONS/DAY
Liquid Hydrogen	118

	PER WEEK	PER DAY
Number of Bases (Non-hardened)	Two	
Base Facility Requirements (Total Both Bases)		
A & T and Cryogenics Manufacture	Provide facilities to give required production rates using days/week and number of shifts specified.	
Launch pads - 3 active; 3 spare per base	12	
Landing runway & facilities 1 per base	2	
(bombers, 1st stage boosters, cargo airplanes)		
Glide bomb recovery facilities Strip 3 per base	6	
Automatic landing control equipment (Time sharing) 2 per base	4	

Ground Tracking and Control System

Vehicle deployment and status (present and future)

Vehicle tracking

Target assignments

Launch and recovery scheduling

Trajectory calculations

Logistics Computation and Control System

Vehicle manufacturing, overhaul, final assembly, launch scheduling

Inventory control; vehicles, spares, supplies

Reliability analysis

Quality control

Communications Systems

Ground - air - ground; wide and narrow band data links

Ground - to - ground; command and general purpose

Personnel Requirements	PER DAY
Flight	300
Direct ground operations	9000
Command and supervision	900
TOTAL	10,200

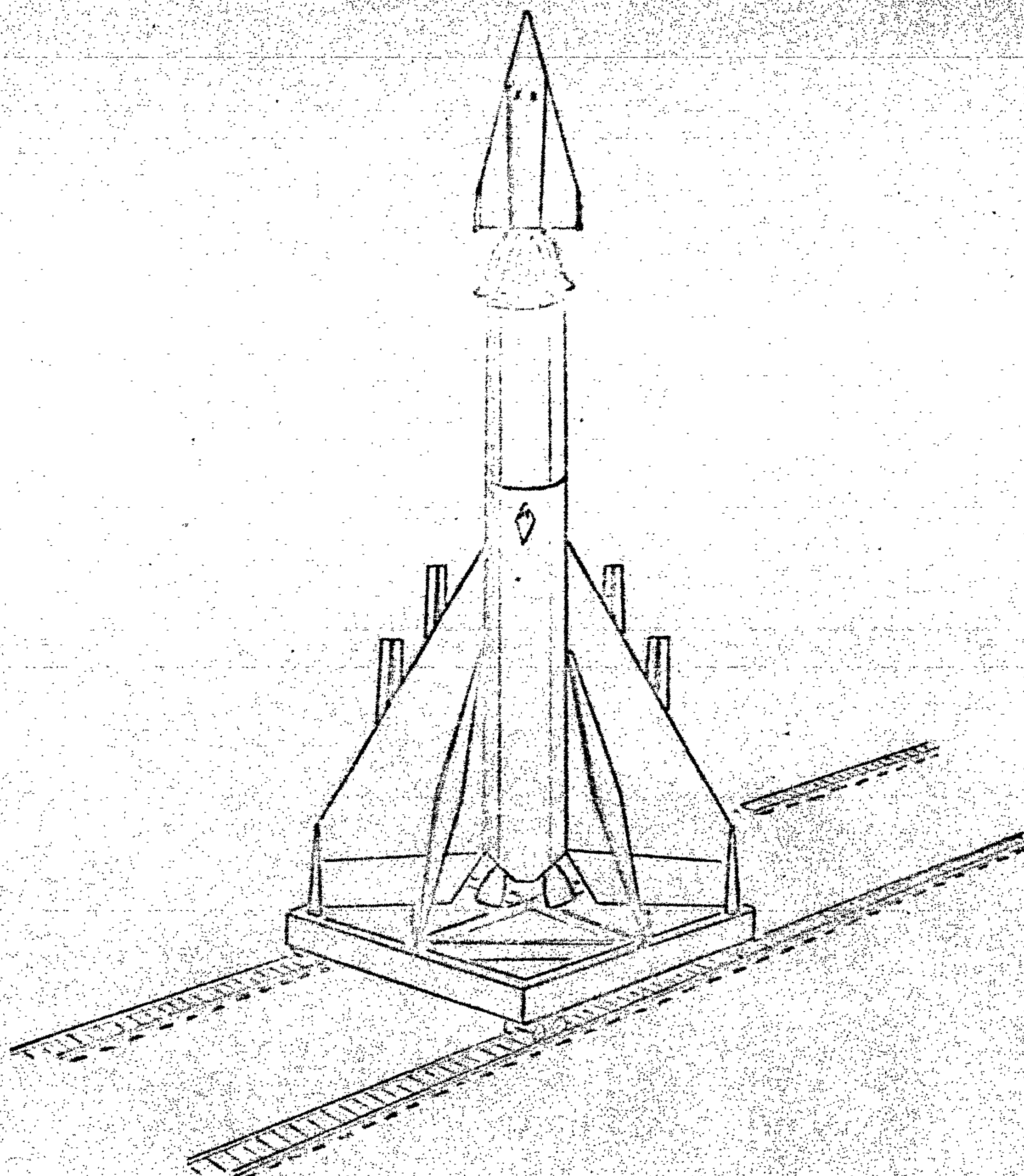
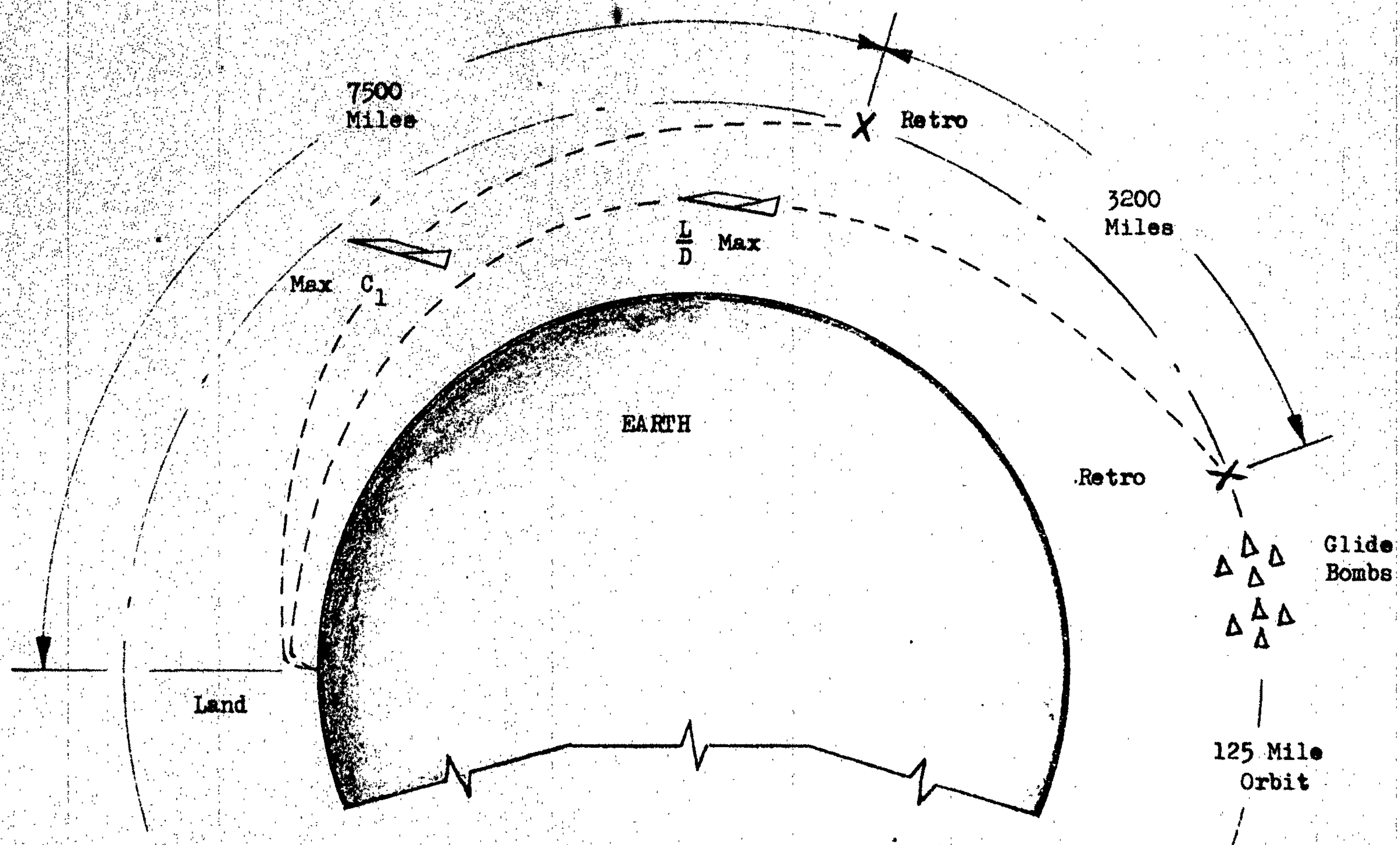


FIGURE IV.K.6



NOTE: C_1 max arrives approx. 14 minutes before $\frac{L}{D}$ max.

FLIGHT PATH EXTREMES - GLIDE BOMB LANDING AT SINGLE BASE

Figure IV.K. 7

4. Contributions of the Man

The manned orbital bomber is scheduled to remain aloft for mission periods of two weeks. With a crew of 3 men a 4 hour duty cycle can be maintained. During full alert, or in emergency all personnel can be at duty stations. The primary duties of the crew involve the monitoring of the status of the bombs and their subsystems, the initiation of warhead arming, and supervising their launching when commanded.

Up-dating of bomber vehicle position must be periodically accomplished to remove accumulated inertial system errors. This may be accomplished by re-indexing on terrestrial check points, taking of star-fixes, and inputs from ground tracking stations.

Target verification and location must be constantly up-dated. This can be done with the sensors subsystems and from inputs from allied reconnaissance systems through ground control or airborne command posts.

Weather reconnaissance information can be obtained with optical and IR sensors, and up-dated knowledge of weather over USSR complex. Radiation monitoring can be accomplished most likely by automatic means with threshold warning devices to alert crewmen to dangerous radiation build-up. In conjunction with reconnaissance system electronic activity (e.g. enemy communication levels) may be monitored periodically by automatic means with threshold warning devices.

The orbital bomber system, while offering tremendous retaliatory strike potential, swift reaction time, and great deterrant effect, poses a critical problem in control.

Overflying friendly and neutral countries, the political and propaganda implications are apparent. The inevitable fear of untoward incidents, e.g. nuclear accidents, disastrous mechanical failure, premature and unwarranted glide-bomb activation and launch, places a premium on fail-safe, positive control of vehicle and subsystem management, warhead arming and bomb launch.

These requirements dictate the fundamental role of the airborne crew members in the system, namely to exercise positive on the spot monitoring and control of the airborne subsystems, especially the warhead arming procedure.

The stringent demands for precise knowledge of vehicle position, up-dated programming of glide bombs, secure and fool-proof communication with ground command, positive monitoring of diverse critical subsystems, capability of in-flight maintenance, appear to make the inclusion of the human component imperative.

IV. MULTI-ORBIT WEAPONS

L. ORBITAL AIR DEFENSE COMMAND POST

1. Operational Concept

The orbital Air Defense Command Post (ADCP) is a manned, recoverable boost-glide vehicle serving as the forward echelon of a divided headquarters where a unit commander and his staff perform their activities operating on a two to four week mission cycle. To carry out its function as a command post, the ADCP must carry with it the power and authority to commit air defenses of the U. S. and its allies. The ADCP must provide increased reaction time to the defense complex, i.e., early warning. Subsidiary to the early warning function is, first, detection of the threat prior to detection by the ground defense complex, and second, evaluation of that threat. Inherent in threat evaluation and in serving as a command post is the capability and the requirement to assign specific defense units to specific threats.

Beyond early warning and threat assignment, the ADCP would participate in intercept of the threat to the following degrees:

a. Serve only in the early warning and assignment function, leaving the balance of the defensive operation to ground defense. Ground defense would search the alerted sector until detection was made, then carry out attack and retrack as determined by the ground commander;

b. Give the armament release order prior to detection by

ground defense, predicated on a calculation of intruder entrance into the ground defense surveillance area. Launch would be timed to permit detection by ground equipment prior to intercept of the intruder, allowing flight correction of the missile before conversion;

c. Give the armament release order, accepting midcourse control of the weapon, vectoring it to lock-on by the terminal guidance system.

The Air Defense Command Post will be concerned primarily with the detection and direction of action against intruders of the following types:

Manned bombers of the B-70 class
Intercontinental glide missiles
Intercontinental ballistic missiles

It appears that to perform its mission economically the Air Defense Command Post will be required to operate on a minimum 14 day mission cycle and at an altitude of 150 nautical miles. A North - South Polar orbit or near polar orbit appears to offer more suitable coverage of the zones of greatest potential threat. The launch - orbit sequence will be comparable to that described for the Orbital Reconnaissance Vehicle - Section IV.A. The ADCP is placed in orbit by the booster system used by the Orbital Command Post Vehicle.

The Orbital Air Defense Command Post System assumes the responsibilities assigned to an orbital reconnaissance system but has the additional responsibilities of evaluating

threat potentials and commanding counter reactions. The reconnaissance function of this system decrees that it overfly enemy territories to maintain early warning surveillance. By overflying the U.S.S.R. and by operating its radar and communications equipment the ADCP vehicle is placed in a highly vulnerable position. The use of the vehicles active reconnaissance sensors give an enemy warning of the vehicles presence and assistance in tracking the vehicle. Also, being in an orbital plane which is coplanor with enemy defense installations allows the enemy to launch attacks upon the ADCP at minimum cost, in that no orbit charging propulsion is required. In that the command post must, to justify its existence, survive a first attack and provide decisions and direction for the air defense of the United States; it must be a defensible system in itself. In the 1965 - 1970 time period, the launching of decoys, to dilute enemy attacks upon the ADCP, appears to be the most feasible approach to ADCP defense. The detection of attacks upon the ADCP and the launching of counterattacks from the ADCP appears to not be practical within the subject time period without a large increase in the system weight or a state-of-the-art break through. In that the mandatory defense of the ADCP is best provided in the 1965 - 1970 period by a passive, non-positive defense, the ADCP concept will not be pursued further until a feasible positive defense concept is evolved.

2. Configuration and Performance

The Orbital Air Defense Command Post vehicle is a larger version of the Orbital Reconnaissance Vehicle (Section IV.A). Its mission objectives, in addition to reconnaissance, are to provide threat evaluation, assignment of ground defense elements and guidance information for ground based interception systems.

The ADCP vehicle is placed in a polar, or near polar, orbit at 150 nautical miles altitude to provide the maximum surveillance potential of the Eurasian land mass, as shown in figure IV.L.1. The normal mission duration is predicated to be 14 to 30 days.

Reconnaissance sensor, data processing and evaluation equipment, and ADCP defense equipment are installed in the vehicle in addition to the environmental and operation equipment. A booster subsystem which includes a manned, recoverable first stage will be utilized with ADCP system.

a. Military Subsystems

(1) Radar

To detect manned bomber and ICGM threats, the use of a high powered search radar is indicated. In addition, a tracking capability in range, azimuth and elevation is essential both to develop threat evaluation and to provide intial launch headings for self-defense missiles. Two radar systems with associated computers are postulated to provide these functions.

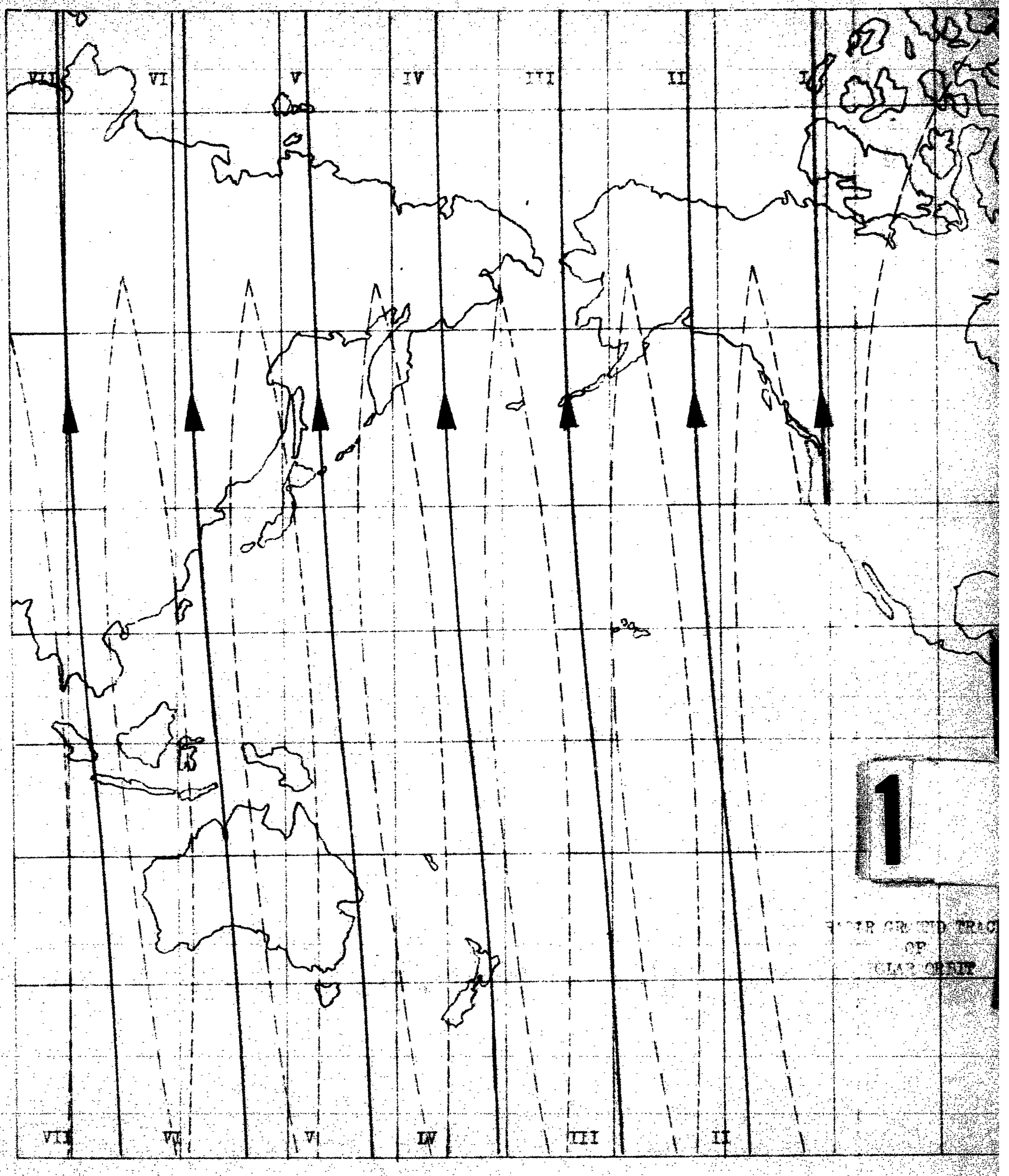


Figure IV.L.1

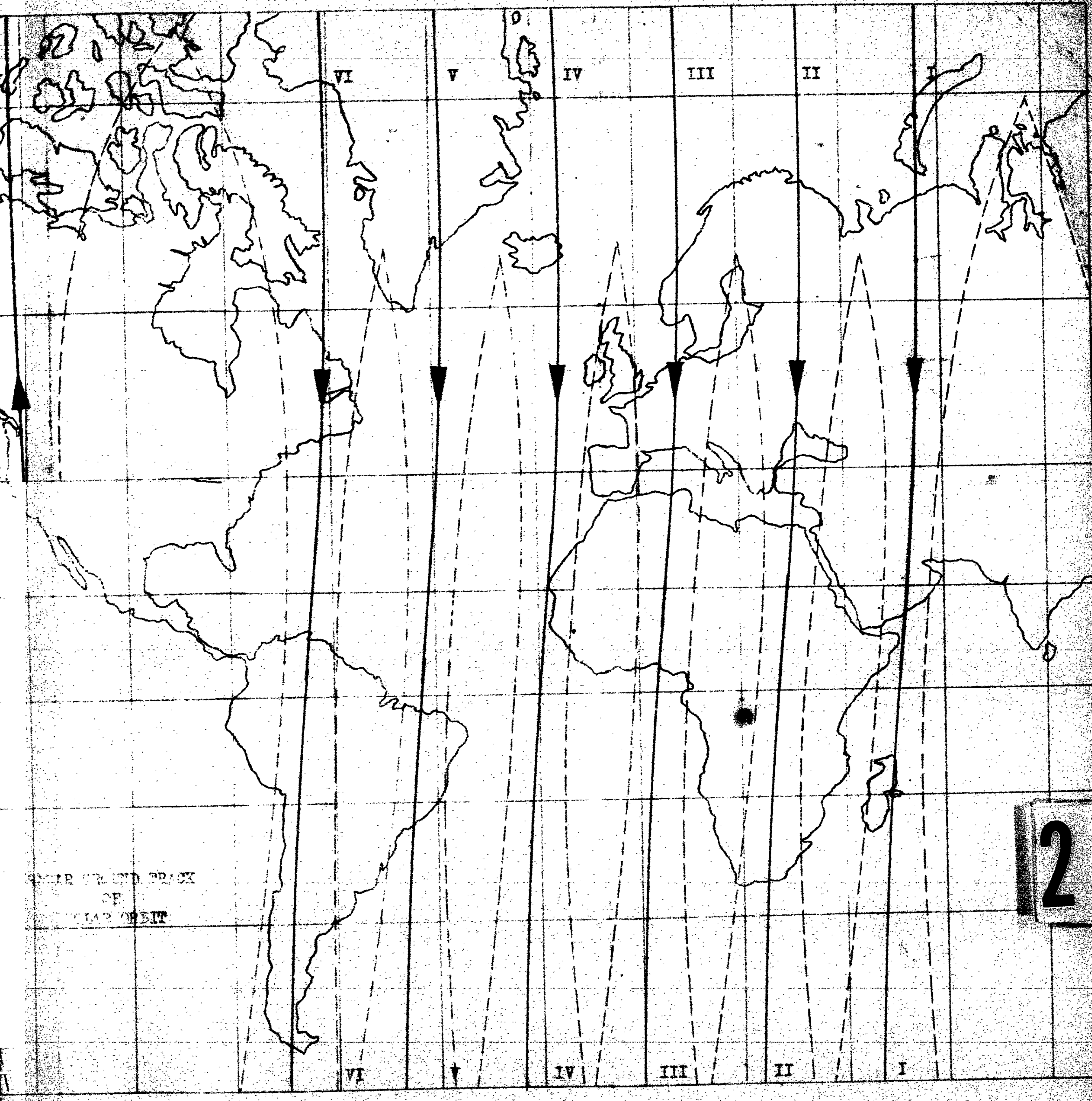


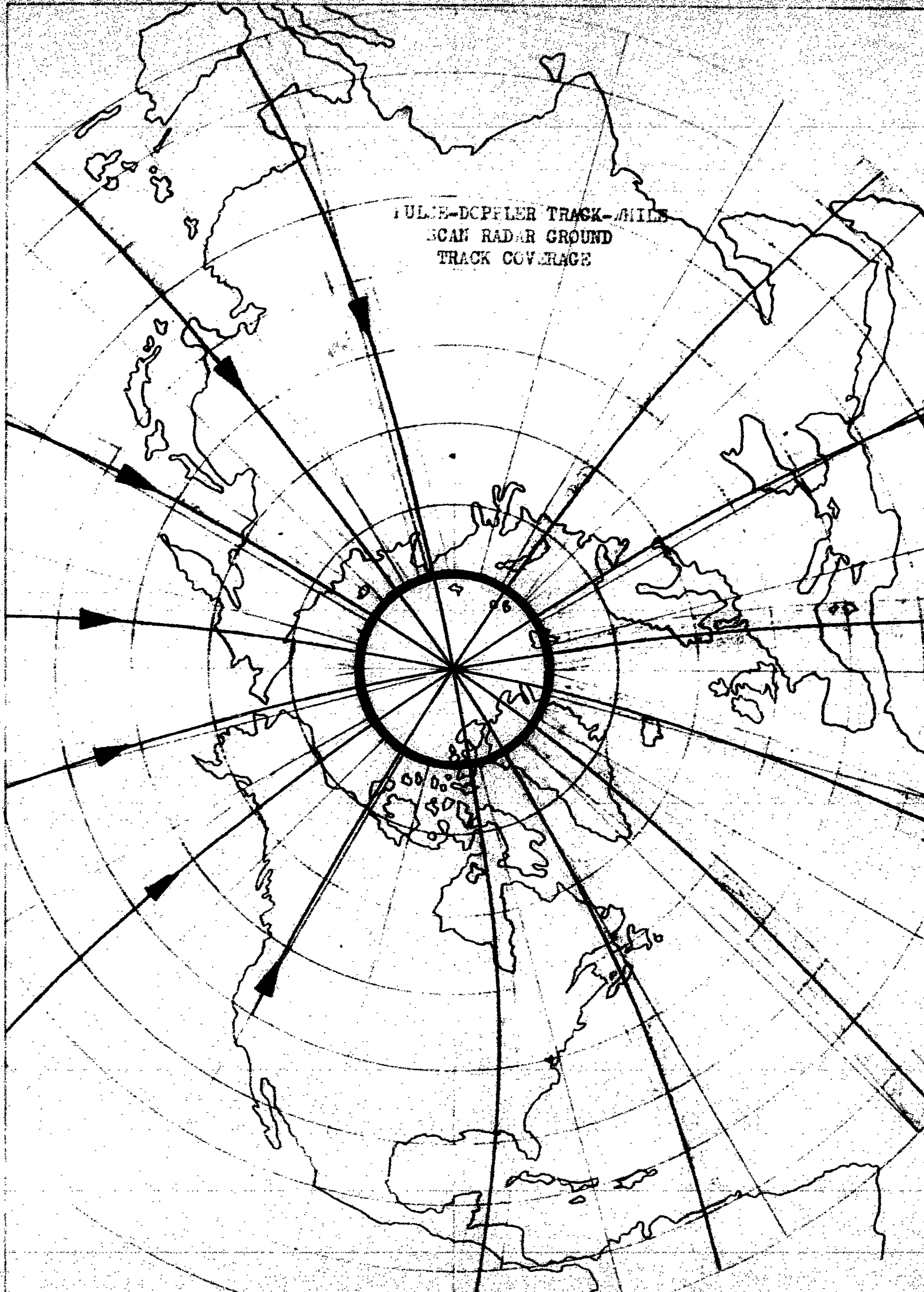
Figure IV.L.1

A 1 megawatt C-band radar with a 360° search pattern in aximuth and a 30° elevation beam width is indicated for the general search function. Parameters and estimated range performance is shown in Figure IV.L.3. This radar will weigh approximately 1,500 pounds, and utilizes a parametric amplifier front end. Pulse compression has not been postulated on the assumption that weight requirements for the TWT magnetic field and increased cooling requirements will be beyond allowable values. The search antenna is assumed partially inflatable and will be jettisoned on re-entry. This radar will provide a look once every four seconds at a given bearing. The coverage obtained is shown in Figure IV.L.1 and contains no gaps (within the four-second frame time) to 145 nautical miles altitude.

It will be noted that, although the performance capability is adequate for detecting B-70 and ICBM class targets whose radar cross-sections will range between 50 and 100 $_m2$ (top aspect), the range for threats to the ADCP itself (.1 $_m2$ to $_m2$ targets) is considerably below that necessary for self-defense requirements. It appears that adequate range performance to detect such threats initially will increase the system weight 350 to 500 pounds above that allowed in the adopted vehicle for the search function alone.

A track-while-scan pulse-doppler radar is postulated to satisfy the early warning tracking requirements. The track-while-scan feature will assist in vectoring the radar in target from the search display. The doppler feature will permit the operator to reject ground returns. The inherent high pulse repetition rate will assist in obtaining a well-defined target track.

Computers will aid the operator in calculating the heading and velocity of the targets of interest. This system will weigh approximately 1,000 pounds. The antenna will be retractable for launch and re-entry, with the total scan field (indicated on the parameter list on Page IV.L.10) positionable in azimuth and elevation. This radar can also be used to supplement general search radar. The coverage in sector scan (pointing aft to the orbit path) is shown in Figure IV.L.2.



BAC 1546 L-R3

Figure IV.L.2

Peak Power	1 megawatt
Frequency	Lower C-band
Antenna Size	120 "X5.6"
Elevation Beamwidth	30°
Azimuth Beamwidth	1.35°
Pulse Length	10 per second
Receiver Noise Figure	1 db
Storage Tube Presentation Gain	2 db
Video Correlation Gain	8 db

Estimated Range Performance

σ (m^2)	R (n.m.)
0.1	75
1	134
10	240
50	360
100	420

Figure IV.L.3

(2) Infrared Equipment

ICBM detection will be accomplished with an infrared system instrumented with an automatic alarm. Characteristics will be essentially the same as that of the Orbital Reconnaissance Vehicle of Section IV. Wavelength coverage will be confined to one of the water vapor absorption bands, which will eliminate any returns below approximately 30,000 feet. Industrial sites and other surface "hot spots" will therefore be eliminated from the display. Interfering stellar bodies will be programmed out by the inertial navigation equipment.

(3) Communication

Frequently updated information of the commitment states of elements of the air defense complex is essential to a command function. This information will be relayed in code to the ADCP over a narrow band high frequency data link periodically. The ADCP will also transmit sightings, bearing information, and air defense assignments over this same link. A beacon-decoder system as indicated

for the Orbital Reconnaissance Vehicle will suffice for ground/space navigation information. It appears desirable also for adjacent ADCPs to intercommunicate on the HF narrow band system or the UFH transceiver.

(4) Guidance and Control

Guidance and control requirements will be the same as those for the Orbital Reconnaissance Vehicle.

Average Power	2,000 watts
Duty cycle	.1
Frequency	High C-band
Antenna Diameter	60"
Beamwidth	2.5°
PRF	Variable (High)
Receiver Noise Figure	5 db
Azimuth Frame	± 20°
Elevation Frame	3°
Scan Type	1 bar
Storage Tube Gain	2 db
Video Correlator Gain	8 db

Estimated Range Performance

σ (m^2)	R (n.m.)
0.1	100
1	180
10	320
50	480
100	570

(5) Vehicle Defense

Manned Air Defense Command Posts in orbit pose a threat to the enemy's capability of delivering successful strategic attacks against the United States. It may therefore be assured that Command Post vehicles would be selected as important targets to be rendered ineffective. It is unfortunate from the standpoint of defending the Command Post itself that its future positions in orbit can be accurately predicted. The most likely enemy weapon systems to be used against orbital Command Posts are considered to be as follows:

Surface-to-space missiles
Space-to-space missiles
Pellets in orbit

Relatively long range interceptions by ADCP defensive missiles (if used) are required. In addition, because of the high velocities of both the attacking and the defensive missiles, an acceptable intercept will in many instances require the defensive missile to be fired when the attacker is at a range which placed stringent requirements on the defensive system radar.

To examine these factors further, a short analysis has been conducted of a postulated ADCP defense system. The system employs defensive space-to-space missiles and receives target range and bearing information from the ADCP radar and its associated computer. The basic missile has the general characteristics of the satellite interceptor missile described in reference IV.F, but active radar rather than infrared tracking is used for terminal guidance. It is assumed that the weight of this radar can be limited to 150 pounds.

Component weights for the defensive missile are as follows:

Item		Pounds
Structure		27
Warhead		50
Electronics		240
Radar	140	
Inertial Plat.	60	
Computer	20	
Power Supply	20	
Equipment		27
Propulsion		to be selected

Weight per Missile 344 pounds plus propulsion weight

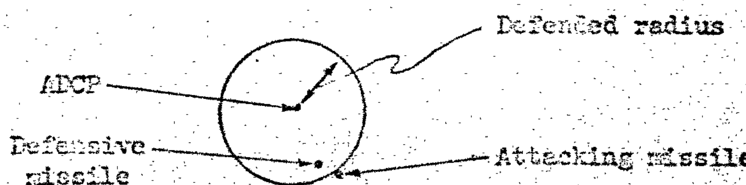
The weight of the missile propulsion will be a function of the intercept maneuvers required of the missile. Figure IV.L.4 relates the missile launch weight to orbital plane rotation and velocity correction.

To determine missile launch weight requirements the following interception situations have been investigated:

Situation No.

(1) The attacking missile is making a head-on interception and will pass slightly below the ADCP.

Slide View



(2) The attacking missile is making a perpendicular interception and is intercepted ahead of the ADCP.

Top View

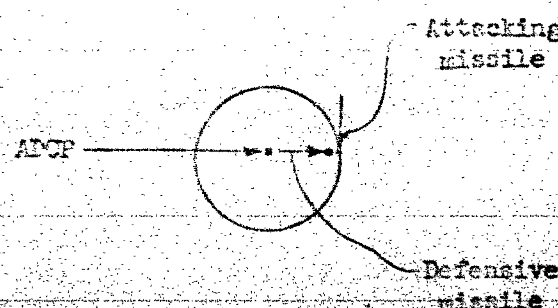


FIGURE IV. L. 5 Intercept Missile Maneuver Capability

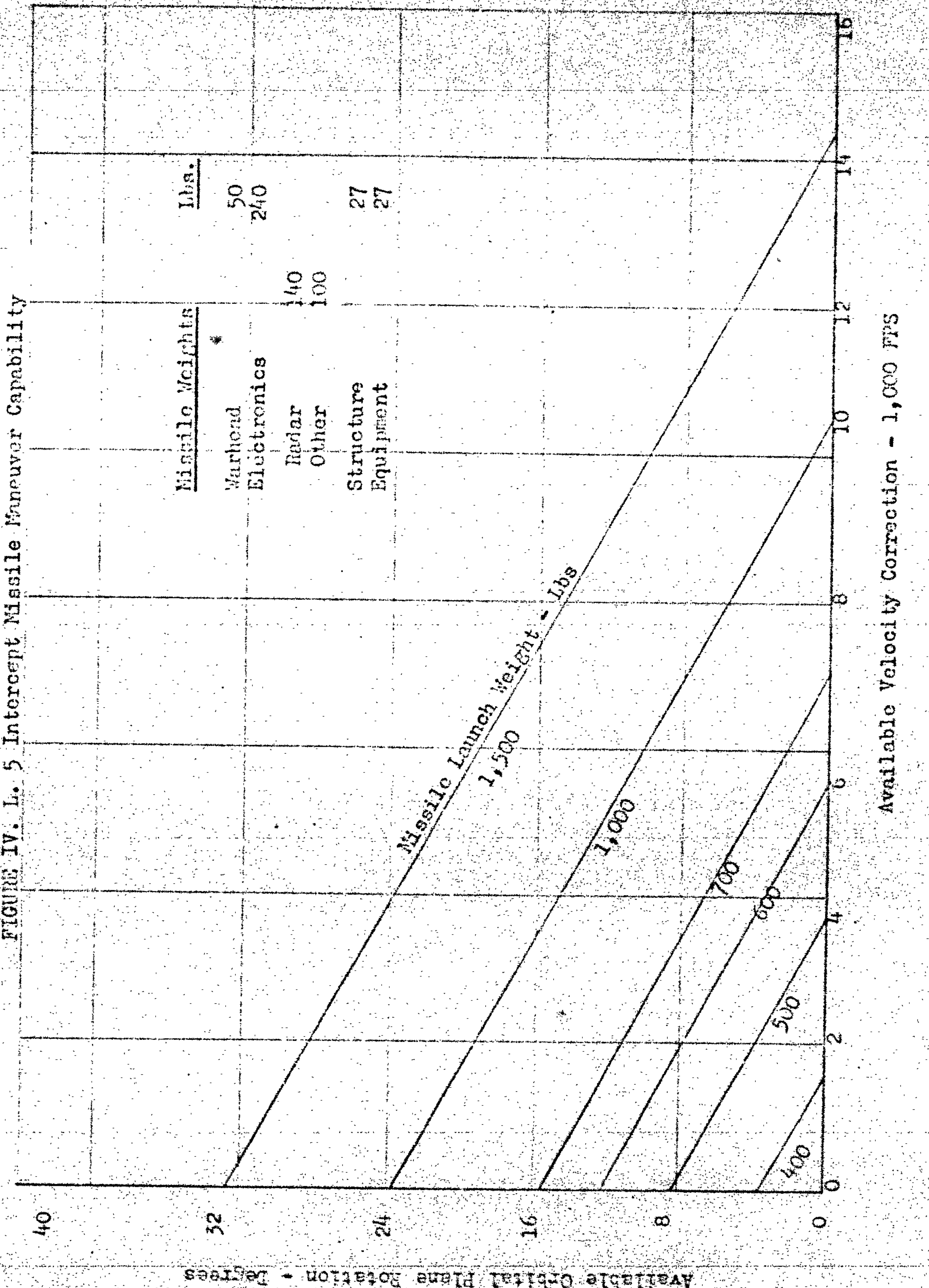
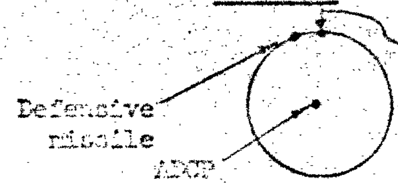


Figure IV.L.4

(3) The attacking missile is making a perpendicular interception and is intercepted at 90° or 270° relative to the ADCP reading.



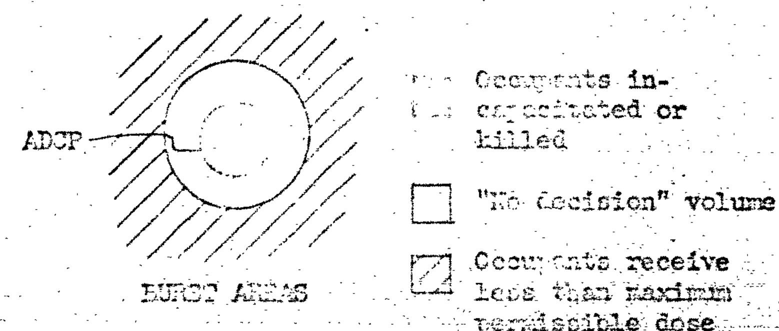
Time does not permit an analysis of the full range of intercept situations. However, situation (1) has been selected to represent a "worst" case for the ADCP defense system. Situations (2) and (3) are considered more likely to occur. In the event the attacking missile approaches the ADCP from astern (the attack situation described in Section IV.F. for a missile launched from an orbital glide vehicle which is coplanar with the ADCP), lower defensive missile weight will normally be required for the interception maneuver than for the three situations examined.

The radius of the defended volume around the ADCP is of importance in analyzing the effectiveness of the defense system. Among the factors affecting the choice of the defended radius are: yield of the defensive missile, expected yield of the attacking missile, maximum tracking range of the defense system radar, shielding provided the vehicle personnel, maximum permissible dose for the personnel,

and the enemy's expected strategy for fuzing the attacking missile warhead. Therefore, the warhead yield must be selected with care. The missile in Section IV.F was armed with a 15 KT warhead, and the same size warhead is assumed here. A smaller warhead may permit the defended volume to be decreased, but the kill probability against the attacking missile would suffer.

An analytical model for the offense-defense duel under consideration can be developed utilizing game theory. The strategies for the offense will depend considerable on its knowledge (or guess) as to whether the orbiting vehicle is manned. A promising strategy against manned vehicles would be to burst relatively large warheads at distances just close enough to be beyond or at the outer edges of the defended volume. Such a strategy would fail if the vehicle under attack were unmanned due to the shorter burst distances necessary for structural kill. The defense is in turn required to base its strategies on an estimate of the size warheads and fuzing strategies the enemy might employ. The range of the defensive radar system, the maximum maneuver capability of the defensive missile, and the allowable radiation dose for the vehicle occupants also serve as constraints on the ADCP defense

doctrine. In the case of enemy action against manned vehicles the game matrix elements can be the radiation doses delivered. The payoff is in favor of the offense if bursts are close enough to deliver a killing dose, and in favor of the defense if less than the permissible dose is received. Between the two significant dose volumes there is a "no decision" volume.



A defended radius of 30 miles has been selected to illustrate missile weight requirements. In each case Figure IV.L.5 has been used to determine the minimum missile launch weight which will permit the velocity correction and/or orbital plane rotation required for the intercept maneuver. Ranges of 250 and 500 miles to the target at time of launch have been considered.

<u>MINIMUM MISSILE LAUNCH WEIGHT</u> (IN POUNDS)

30 mile Defense Radius

Intercept Situation	Range at Launch 250 Miles	500 Miles
1	750	530
2	555	430
3	595	440

293
c

Propulsion weight of about 20-25 pounds (total missile launch weight about 365 pounds) will be adequate for defense in most cases in which the attacking missile approaches from astern.

The effect of varying the range at launch and the length of the defended radius on missile weight for a specific intercept situation is as follows:

Parameter Change	Missile Launch Weight Increased	Missile Launch Weight Decreased
Defended radius increased, launch range, unchanged	x	
Defended radius decreased, launch range, unchanged		x
Launch range increased, defended radius unchanged		x
Launch range decreased, defended radius unchanged	x	

Although it is desirable to increase the defended radius for personnel protection and to decrease the launch range requirements to reduce the power requirements and the weight of the radar utilized for defence purposes, both changes result in heavier defensive missiles. For 10-15 KT defensive missiles the defended radius of 30 miles must be considered a very risky minimum if the permissible dose is 50 r since one burst at that range will deliver about that dose (unless very effective shielding is provided). Needless to say, more than one defensive

missile detonation or the accidental triggering of the attacking missile's warhead would result in much higher doses to the crew unless the defended radius were increased appreciably. If intercept situation 1 is ruled out (on the basis of a low probility of occurrence) the minimum defense missile weight is estimated to be about 550-600 pounds if launch ranges are of the order of 250 miles, and about 425-450 pounds if launch ranges of 500 miles can be provided. The probability of achieving the longer launch range is low, due to a more sophisticated defense system requirement. It is also low because the target must be detected and tracked at a greater than the launch range, and at such ranges there may be considerable difficulty in obtaining accurate tracking information and evaluating the seriousness of the threat to the ADCP. It must also be added that the missile storage problems and the launching requirements to meet threats from all directions create significant problems.

One approach to the defense missile system would be to limit the weight of the missiles to 375-400 pounds to counter only a limited variety of attack threats, such as overtaking missiles.

Additional means, both active and passive in nature,

of defending the orbiting ADCP are listed and briefly discussed below:

(a) Use of decoys
(b) Changing orbital altitude or orientation
(c) Use of electronic countermeasures
(d) Use of radiative-type defense weapons

The employment of decoys in the same orbit with manned vehicles has been discussed elsewhere in this document. Section IV.A describes placing ten decoys in orbit with each manned reconnaissance vehicle. The effect of this strategy is to raise the enemy's cost of destroying a manned vehicle. The use of decoys as part of an ADCP operation appears very attractive. To confuse the enemy it may prove expedient to install in in the decoys electronic equipment having propagation characteristics similar to those of the ADCP.

In the face of an incoming, accurately directed missile, the ADCP may attempt to evade, through changing its altitude or orbital plane. Such actions normally will not be desirable because of the propulsion material weight required, and also because the continuation of a planned orbit will be vital to successful pursuit of an early warning function. Nonetheless, orbital reorientation may be reserved as a possible emergency procedure.

ECM may be employed to jam the attacking missile radar. Disadvantages here are the weight of the ECM equipment that would be required in the ARCP and the fact that attack by several missiles using different operating frequencies may create a situation that the ECM gear cannot cope with.

As illustrated previously, personnel protection may be obtained by providing shielding in the vehicle. Trade-off studies should be conducted to establish the degree of defense achieved by using the available weight for a defensive missile system or for shielding, ECM equipment or orbital reorientation propulsion.

More detailed information on the Orbital Air Defense Command Post can be found in reference 23.

IV. MULTI-ORBIT WEAPONS

M. SURFACE TO SATELLITE TRANSPORT

1. Operational Concept

The primary mission of the system is the transportation of personnel, high security or bulky data, and expendable or critical materials and equipment to and from orbital systems. A hypersonic glider is utilized as the transport vehicle to provide latitude in de-orbit times, choice of landing sites, and in minimizing deceleration forces on the crew and passengers.

In the 1956 - 1975 era manned space vehicles of various types will be in orbit around the earth and each will require logistic support. The personnel manning these systems require rotation and return to home bases after 2 to 4 weeks on station. The missions of some of the orbiting systems requires collection of large amounts of data too voluminous for transmittal over wide band data links and thus it must be returned for reduction and evaluation. The equipment in use on board the orbiting system requires maintenance, repair or replacement, and expendable materials must be replenished. Therefore, the transport is utilized on a scheduled basis to perform the logistic tasks. It is possible that more than one space vehicle can be supplied in a single mission; however, for large systems only a single orbiting vehicle can be replenished.

The vehicle is prepared for flight following designation of the orbiting station to be supplied. Loading of all stores except personnel and expendables such as liquid hydrogen or oxygen is accomplished and then the first stage recoverable and second stage non-recoverable boosters are fueled. Expendables, stores and then personnel are loaded in the vehicle and final countdown initiated. The actual time of launch and the preparation of the system for the mission depend upon the orientation of the launch site to the orbital plane of the vehicle to be supplied. At the end of the countdown, the transport is boosted into a lower altitude orbit coplanar with the orbit of the vehicle to be contacted.

Because of the differences in the individual orbital velocities, the transport overtakes the other satellite vehicles. As the correct lead angle is reached, additional thrust is applied to the ferry vehicle resulting in an eliptical orbit transfer. Data on the firing times of the rocket engines is supplied to the transport guidance and control system from ground installations. The transport radar is utilized only for the final mating maneuver because its range is limited. A beacon provided on the satellite vehicle minimizes power requirements and increases detection range of the transport radar system.

In order to determine the possible military utility, determine size, investigate the ground complex and estimate costs, a weapon systems concept involving the actual use of re-supply vehicles had to be developed. This study weapon system

represents only one of the uses for the surface to satellite transport.

2. Application Study for the Surface to Satellite Transport

The military system chosen for the application studies provides the same imminence of hostility coverage and reconnaissance capability provided by the 14-day 3 man reconnaissance system described in Section IV.A. The vehicles are in a 200 n.m. altitude, near polar orbits which are spaced longitudinally at 120°. Nine satellites are in each orbital ring.

The Surface to Satellite Transports (Figure IV.M.1) operating from 2 bases, e.g., Loring and Fairchild, rotate the crews and carry equipment, food and other expendables to the orbiting reconnaissance vehicles. On the return leg of the mission the transport bring back the retiring crew, and reconnaissance data that has not been transmitted over the electronic data links. The satellites are supplied and crews are rotated at 30 day intervals. This requires [illegible] freighter missions a year.

Results of the study indicate transport vehicles supplying permanent orbit reconnaissance satellites can effect large savings over systems such as described in Section IV. .

	Satellite Transport Re-Supplied Reconnaissance System	14-Day Manned Orbital Reconnaissance System
Firings	330 Transport/Year + 27 to Setup Satellites	702/Year
Total Weight put in orbit	5,620,000 lb./Year +775,000 to set up Satellites	12,750,000 lb./Yr.
Launch Weight	230,000,000 lb./year + 1[illegible],0[illegible],000 to set up Satellites	490,000,000 lb./Yr.
Bases	2	2
Launch Pads	8	10
Transport Vehicles	24	56
Recoverable Boosters	15	18
Personnel	2090*	3455

The 14-day manned orbital reconnaissance system (Section IV [illegible]) could be made operational at an earlier date than the transport satellite system because the first system requires no rendezvousing of vehicles in orbit. Demonstration of the orbit matching ability could be programmed into the DS-I research program in 1964 - 1965 time period.

* Includes crews necessary for man satellites described in this section.

3. Transport Configuration

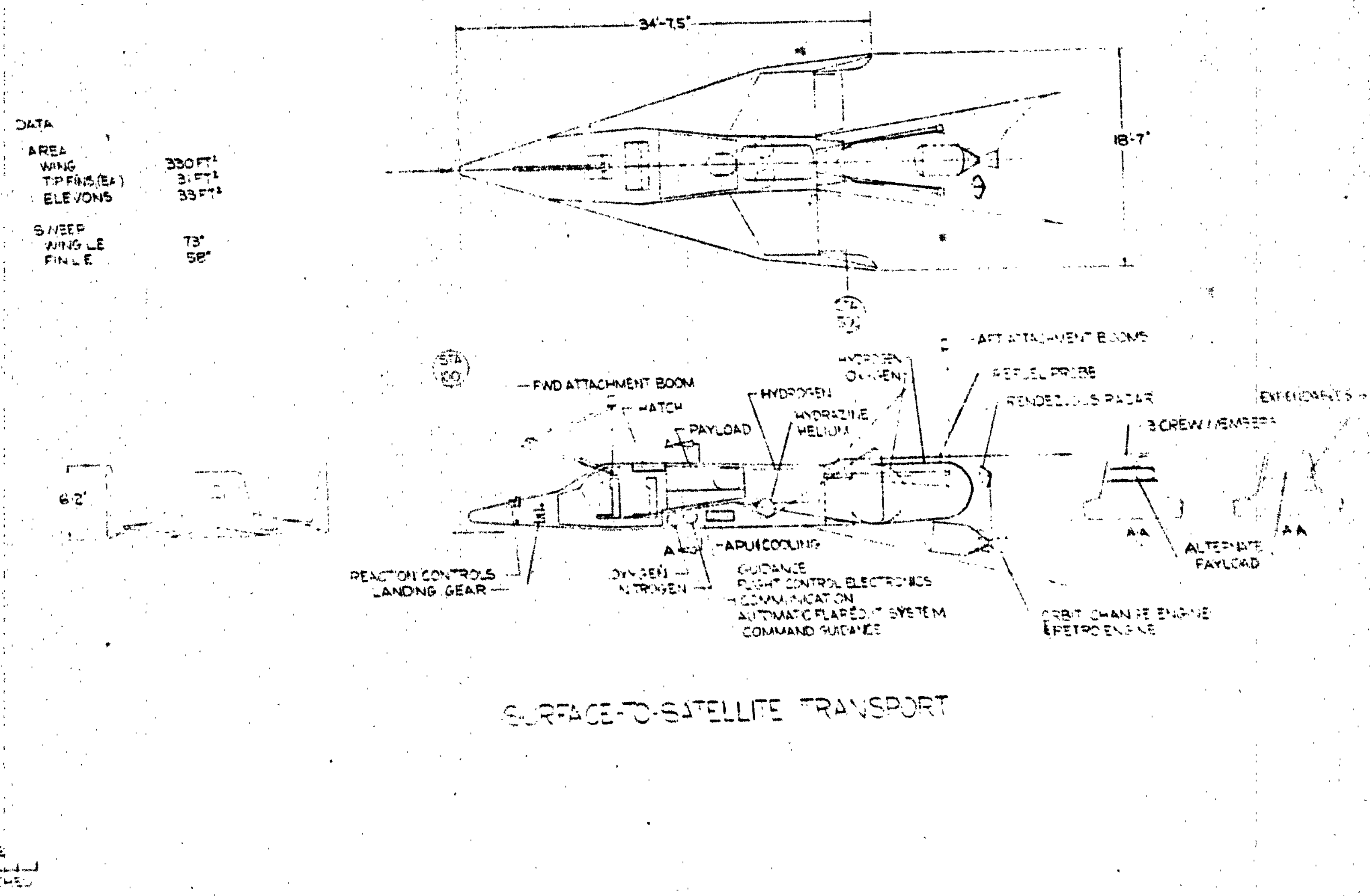
a. Performance and Configuration

The transport of this system Figure IV.M.1 is similar in appearance to the DS-I. It has the same geometric planform and the same wing area. The body, however, is wider to accomodate the passengers and cargo which are carried inside. A jettisonable pod at the back carries the fuel for the satellite and the orbit changing engine.

The orbit changing engine is a liquid rocket allowing control of the impulse for contact and attachment to the satellite. 560 pounds of orbit adjustment fuel are supplied. Join up maneuvers are made using reaction controls and translating thrust jets, controllable in amplitude and duration.

The grappling arms are positioned with one stowed along the top of the body and the other two stowed on the jettisonable pod. The three hinged arms will withstand the foreseen tension and compression loads. Join up with orbital vehicles will be with the top side hatch to the hatch of the orbiting vehicle. In the case of a join up with other friendly glide vehicles such as the Manned Orbital Reconnaissance vehicle the contact will be top to top. In all cases the top location of the foreward arms permits direct pilot vision during the attachment maneuver.

A nozzle designed for the connecting arm attachment



SURFACE-TO-SATELLITE TRANSPORT

FIGURE IV.M.1

heads will provide reaction on the satellites surface to eliminate any roll or pitching motion that exists. Incorporating "tee" nozzles in the head automatically compensates for reaction and simplifies maneuvering control problems.

Using the extensible arms for delicate motion arrestment at join-up will protect both vehicles as the outrigger arm will absorb contact shocks. The attachment head on the arm contains a latch - unlock mechanism designed to couple with a socket on the satellite.

The personnel are seated with the pilot forward and two crew members side by side and to the rear of the pilot. Food, water and other expendables carried in the pressurized compartment are located aft of the crew. This cargo is packaged in a cavity shape which allows three men to occupy this volume when emptied of supplies and equipment. These three men would be carried in a supine position which is suitable for re-entry only, permitting the same vehicle to perform rescue missions.

The fuel tanks carried in the pod aft of the glider are equipped with fuel lines which automatically connect to the satellite. Fuel and other liquid expendables may then be pumped into the satellite storage tanks. The transport does not return the pod to the earth.

The vehicle is designed to carry 3 men and 4,550 pounds of materials and equipment to a satellite orbiting at 200 N.M. altitude. The materials and equipment will consist of such items as food, water, breathing and power oxygen, power hydrogen, pressurization nitrogen, replacement reconnaissance equipment film and tape, etc.

Preliminary Weight Statement:

Item	Weight-Pounds	
Wing	800	
Body	2,380	
Fins	360	
Control Surfaces	430	
TOTAL STRUCTURE		3,970
Auxiliary Power System (Incl. 150lb. fuel)	450	
Reaction Control Sys. (Incl. 200 lb)	310	
Hydraulic System	90	
Electric System	300	
SECONDARY POWER SYSTEM		1,150
Crew Cab Environmental Control (Incl. 250 lb. expendables)	930	
Equipment Compartment Environmental Control (Incl. 50 lb. expendables)	520	
TOTAL ENVIRONMENTAL CONTROL		1,450
ELECTRONICS		1,200
FLIGHT CONTROLS & MECHANISMS		650
LANDING GEAR		310
CREW OPERATIONS (Incl. 3 crewmen)		920
BASIC GLIDER GROSS WEIGHT		9,850
Food & Water	460	
Liquid Nitrogen	70	
Liquid Hydrogen - Accessory Power	360	
Liquid Oxygen - Accessory Power	2,860	
Pressurizing	110	
Breathing	190	
Replacement Equipment -Film, Tape, Etc.	500	
TOTAL PAYLOAD		4,550
Orbit Change & Retro Rocket Engine	150	
Fuel System Tankage & Plumbing	600	
Fuel - Orbit Match	560	
Retro	250	
Interstage Structure	1,100	
AFT POD		2,660
GLIDER + POD GROSS WEIGHT		17,060

b. Guidance and Control

The Transport vehicle has several novel guidance and control problems arising from its mission. The complete guidance and control system is outlined in Figure IV.M.2. Each phase of the mission will be described in turn.

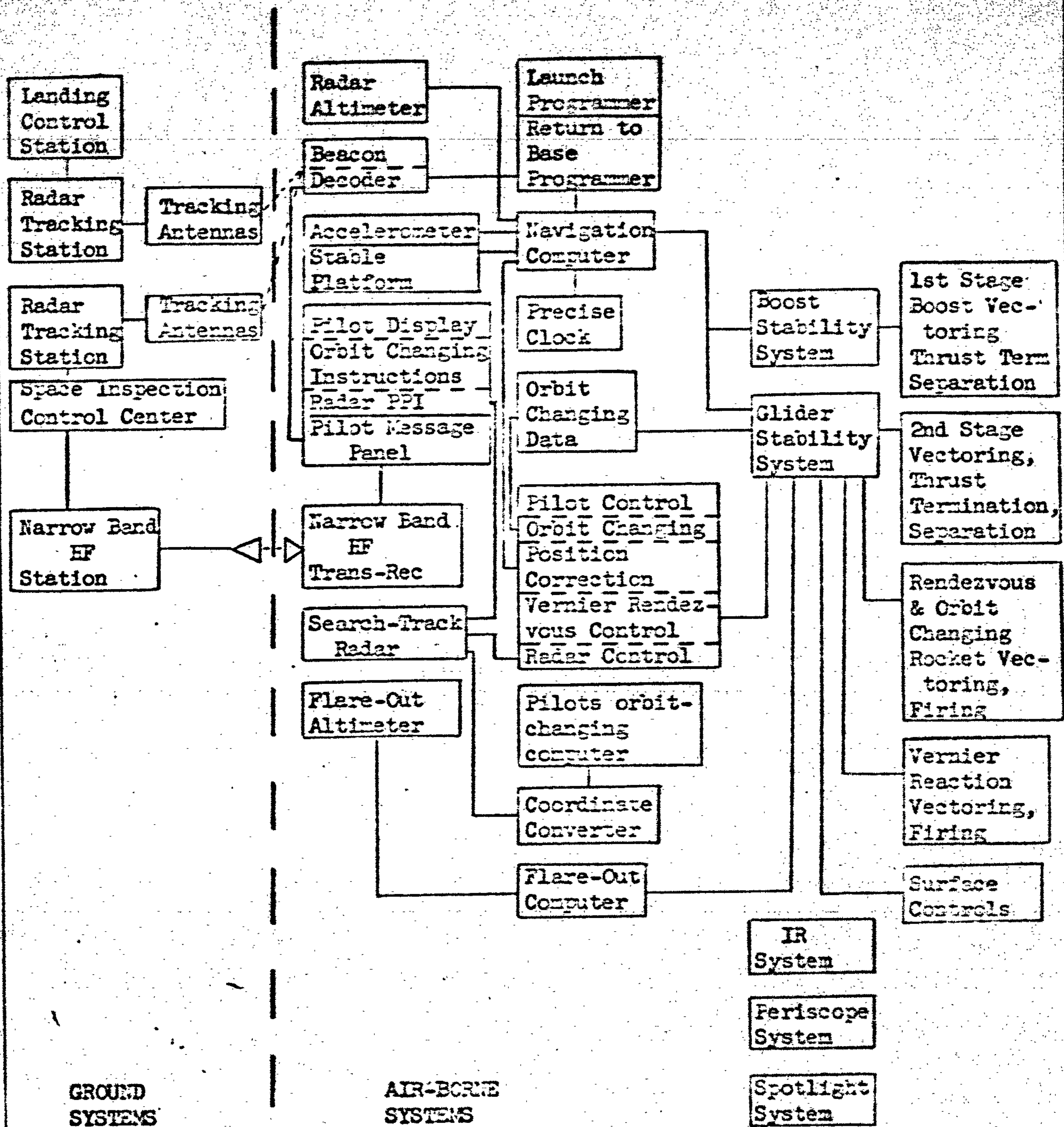
(1) Launch Phase

The vehicle contains a basic precision inertial auto-navigator for use during all phases. This navigator has adequate accuracy for launch. The launch control system is similar to that described for other Dyna Soar vehicles.

(2) Rendezvous with a Satellite in Orbit

The existance of accurate satellite tracking and orbit computation stations in the United States is assumed for the time period of interest. The Transport is launched into an orbit at a higher or lower altitude, than the vehicle to be supplied, but in the same orbital plane.

A small X-band search and track radar locates the vehicle, determines its satellite position and velocity. The data are entered into a semi-automatic "orbit changing" computer which determines the direction and magnitude of rocket impulse required to approach the satellite. To conserve rocket fuel, the rendezvous operation may take an appreciable fraction of an orbit period, so that a simple "closing" course is not called for. When the carrier gets close to the orbital vehicle, the pilot



(Figure IV.M.2.) GUIDANCE AND CONTROL:

applies final correction thrust. He then maneuvers using vernier reaction controls to rendezvous within 100 feet. Optical aids, rendezvous radar and a spotlight are supplied to aid in this operation.

(3) Orbit Changing

Instructions for changing from one orbit to another normally is furnished to the vehicle prior to take-off. If, due to unforeseen delays or change of plan, the pre-determined instructions are no longer valid, the pilot can take either of two courses. He can request new instructions from the ground station through his narrow band HF communication system. Or, he can compute his own orbit changing procedure using the semi-automatic computer used for the rendezvous operation. This latter procedure is less precise and results in use of more rocket fuel than otherwise required.

For minimum use of rocket impulse the orbit changing operation may take several hours to complete. When the transport orbital plane is inclined to the satellite plane, the transport waits until it crosses the latter and then changes course into the satellite plane. In order to "catch-up" or "slow-down" to the satellite the transport will change its radial velocity, thus changing the angular rate at which it rotates around the earth.

A rocket impulse capability for orbit changing of 500 feet/second is required on the average.

(4) **Return to Base**

The orbit-changing computer will be used to calculate time to leave the satellite and retro rocket control program. Otherwise, the landing system is the same as for other Dyna Soar vehicles.

To avoid excessive accumulation of navigation error during a prolonged mission, the navigator can be corrected periodically upon rendezvous with a satellite (the satellite's orbit has been accurately determined prior to take-off) or upon passing over one of the United States tracking stations. In this way navigation errors can be kept below 20 miles, which is more then adequate for landing.

Communications

UHF Voice Transceivers: A system for two-way voice communication for landing instructions from tower and for communicating with other vehicles is included. This transceiver has been described in earlier sections of the document.

c. Miscellaneous Vehicle Subsystem

(1) This vehicle has a flight duration of 24 to 35 hours, with a normal electrical load of several kilowatts (Figure IV.M.3) and a high hydraulic load during re-entry.

	LAUNCH	TARGET	GLIDE	LAND
GUIDANCE & CONTROL				
Radio Guidance	65			
Platform Electronics	400	400	400	400
Computer	350	350	350	350
Orbit Changer Computer		20		
Flight Control Elect.	310	310	310	310
Landing System				270
RECONNAISSANCE		1500		
COMMUNICATIONS				
Landing Beacon				100
UHF Transceiver				200
Narrow-Band Receiver	100	100	100	100
Narrow-Band Transmitter	400	400	400	400
ELECTRONIC LOAD TOTAL	1625	3080		
EQUIPMENT BLOWER CABIN BLOWER, LIGHTS	1000	200	200	1000
TOTAL ELECTRIC LOAD	2625	3280	1760	3130 W.
HYDRAULICS (2 SYSTEMS)				34 H.P.

FIG. IV.[illegible].3. SECONDARY POWER - LOAD ANALYSIS

The relatively short flight time permits the use of liquid hydrogen and oxygen for fuel, and this choice gives a specific fuel consumption substantially lower than available from a hydrazine APU. Electric power during cruise is most economically furnished by the hydrogen-oxygen engines.

The requirement of immediate readiness can be met by keeping the liquified gas tanks filled at all times. Calculations based on new installations indicate that a 5% per month boiloff is possible, and a tank that is topped once every two weeks would need to be only about 3% oversize.

In the resulting system (Figure IV.M.4), fuel from insulated tanks is vaporized in a heat exchanger where it absorbs equipment - compartment heat. The fuel then goes to two positive displacement engines. Each engine drives an A.C. generator feeding an A.C. bus. The generators are automatically paralleled. A transformer-rectifier provides D.C. power.

Each engine also drives a hydraulic pump which supplies hydraulic power to the flight control actuators. Associated with each of the pumps is a hydraulic system consisting of an accumulator, a reservoir, a relief valve, a filter, a pressure switch, and necessary valves, lines and fittings. At the required operating altitudes aerodynamic controls are ineffective. Attitude

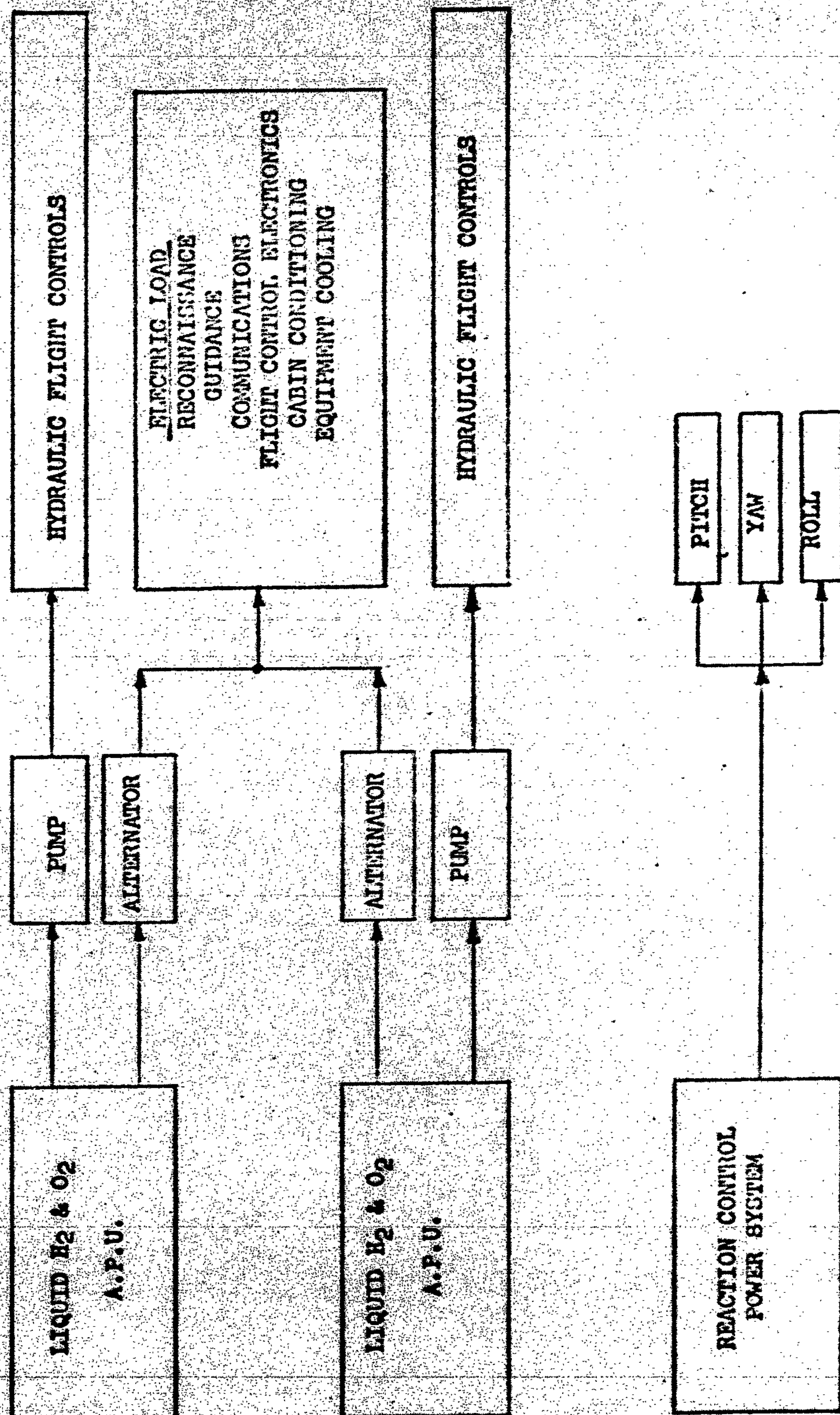


FIGURE IV.N.4 SECONDARY POWER SYSTEM

control during this phase of flight will be provided from a reaction control system. This system will share a common fuel supply with the hydrogen-oxygen engines. The entire secondary power system including the heat exchanger is contained in a single integrated package.

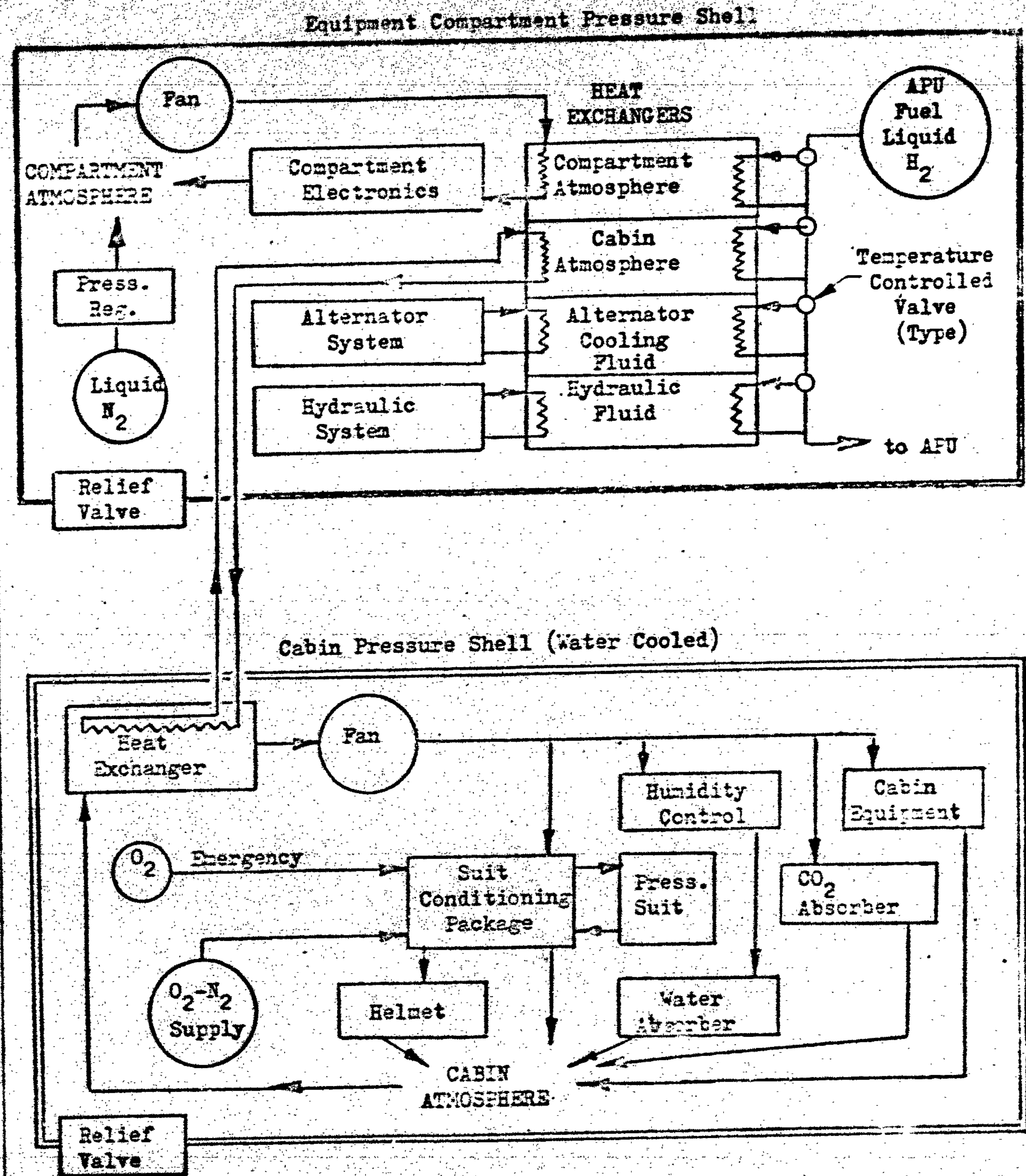
(2) Environmental Control

The vehicle has two pressurized, conditioned compartments which contain the bulk of the glider equipment and crew. A limited amount of cooling is accomplished outside the compartments.

The cabin compartment contains the life support system. The atmosphere of nitrogen and oxygen is maintained at 8.3 psia. Atmospheric leakage is held to 1 pound per hour. Oxygen partial pressure is 3.08 psia (sea level equivalent). The temperature is controllable from 50° to 90°F. Relative humidity is maintained at 40% ± 10%, and carbon dioxide partial pressure is less than 4 mm Hg. (0.93% concentration) through the incorporation of chemical absorbers. Cooling is accomplished by circulating the atmosphere through an ethylene glycol-water heat exchanger from which the heat is transported to a liquid hydrogen heat exchanger. The liquid hydrogen fuel on the way to the secondary power system engines provides the heat sink for both the cabin and equipment compartment systems. Passive water cooling is used on the outside of the cabin

pressure shell to absorb aerodynamic heating during re-entry.

The equipment compartment contains most of the vehicle electronic and other temperature sensitive equipment. A separate environmental control system provides cooling by circulating a cold nitrogen gas atmosphere, which transfers heat to the hydrogen fuel as it flows to the secondary power units. Aerodynamic heat entering the aft compartment during re-entry is also removed by the circulating nitrogen gas. The compartment is pressurized to 10 psi from a liquid nitrogen source. A schematic diagram of the environmental control systems is shown in Figure IV.M.5.



ENVIRONMENTAL CONTROL SYSTEM

Figure IV.M.5

4. Booster System Configuration

The booster, Figure IV.M.6, for the Surface to Satellite Transport vehicle is a two stage booster. It has the same configuration as the booster system for the 3 man 14 day reconnaissance vehicle. The first stage is recoverable. It uses liquid oxygen and liquid hydrocarbon propellants. The second stage goes into orbit with the glider and is expendable. It uses liquid oxygen and liquid hydrogen propellants. See Section V for more information on boosters.

The first stage attains a burnout velocity of 6,100 fps. The upper stage then has the capability of placing a 17,060 pound payload in a 400 nm. altitude circular polar orbit. For missions requiring less ideal velocity the upper stage is not loaded with propellants to its full capacity.

Weight Statement

	Weight - Pounds
Glider	17,060
Second Stage	
Burnout	29,100
Propellant	127,500
Start Burning	158,660
First Stage	
Weight Empty	81,900
Pilot	250
Trapped Rocket Prop.	4,300

317
c

	Weight - Pounds
Turbojet Fuel	16,000
Propellant	432,000
Launch Weight	693,110

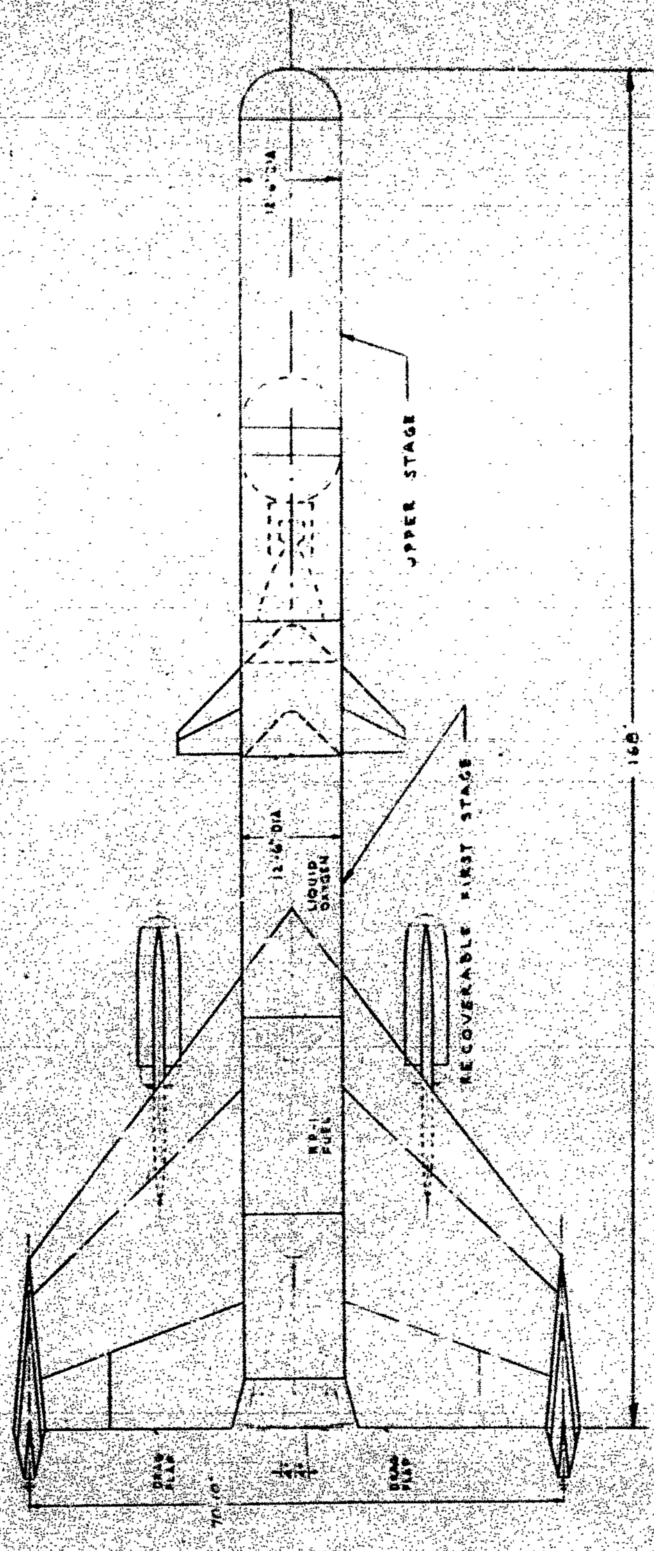

UPPER STAGE
RECOVERABLE FIRST STAGE
LIQUID OXYGEN
RP-1 FUEL
12'6" DIA
168'
70'10"

FIGURE IV M-6

4. GROUND SYSTEMS AND SUPPORT

a. Introduction

Ground system planning is based on the flight hardware described previously, plus the following operational requirements and assumptions:

Number of Bases: Two (Boeing and Fairchild).

Vulnerability Allowable: Hardening not required.

Normal Launch Rate: One firing every two days at each base.

Emergency Launch Rate: One firing per day for five days at each base, in addition to the normal launch schedule.

Reaction Time: As required to meet normal launch schedule. Emergency flights must be launched within one hour of mission decision.

Recycle Time: Base operations are planned for fourteen day glider recycle time; eight days for recoverable first stage boosters.

Work Periods: Launch and recovery area operations are carried on seven days a week as the launch schedule may dictate. Overhaul, final assembly and test operations are equipped and manned to satisfy the normal launch schedule vehicle requirements on a five day, single shift work week. Emergency vehicle stocks are replaced by scheduling overtime or adding extra shifts.

Force Size: Total force size is 24 gliders; 16 first stage boosters.

b. Base Complex

One half on the vehicle force is stationed at each base. Facilities, equipment, and organization are identical at both locations.

Each base is responsible for the following functions: new glider major assembly and checkout; overhaul of recovered gliders and first stage boosters; vehicle final assembly; launching; glider and first stage landing and recovery. For maximum safety and efficiency, the base layout includes an industrial area, launch area, and recovery area in which appropriate functions are segregated. Headquarters, training, personnel housing and base support functions are also grouped separately for similar reasons.

One 10,000 ft. runway is required at each base for glider and first stage booster landings. Other aircraft use this runway as well, due to the low frequency of utilization by satellite transport system vehicles. Emergency arresting gear and vehicle decontamination equipment are provided.

Separate storage and work areas are provided for all operations involving hazardous materials in accordance with applicable safety regulations. Revetments are provided as required. Defueling and purging facilities are included in this category. A remote facility is also required for static firings of the first stage rocket engines during major overhaul periods.

Six launch sites per base are provided to support the operational requirements of the weapon system. Each site is equipped with a

retractable shelter and an erection mechanism capable of receiving the vehicle on its strongback. Insulated storage and pumping facilities are located at each site to provide LOX and liquid hydrogen immediately prior to launch.

Launch control and monitor equipment and personnel are housed in a blast-proof cubicle which is located on the launch site. A central operations building is located in the middle of the launch complex; the chief launch coordinator, ground launch personnel and pilots on alert status are stationed in this building. Command communication channels are provided to each site. The central operations building is also tied into the SAC communication network.

Short range training flights can be launched from a separate base such as Vandenberg AFB. Frequent peacetime use of the system enables operational missions from the operational base to be used in lieu of full scale training flights.

c. Sequence of Events

New major vehicle sections - first stage recoverable boosters, second stage boosters and gliders, - are processed in the following manner.

First stage recoverable boosters are received on a fly-in basis from the manufacturer. These boosters are received complete with all non-integrated flight systems, such as communications, beacons, etc.

Upon acceptance, the boosters are transferred, on their own landing gear, to a storage area. From this area, they are fed into the final assembly area per schedule requirements.

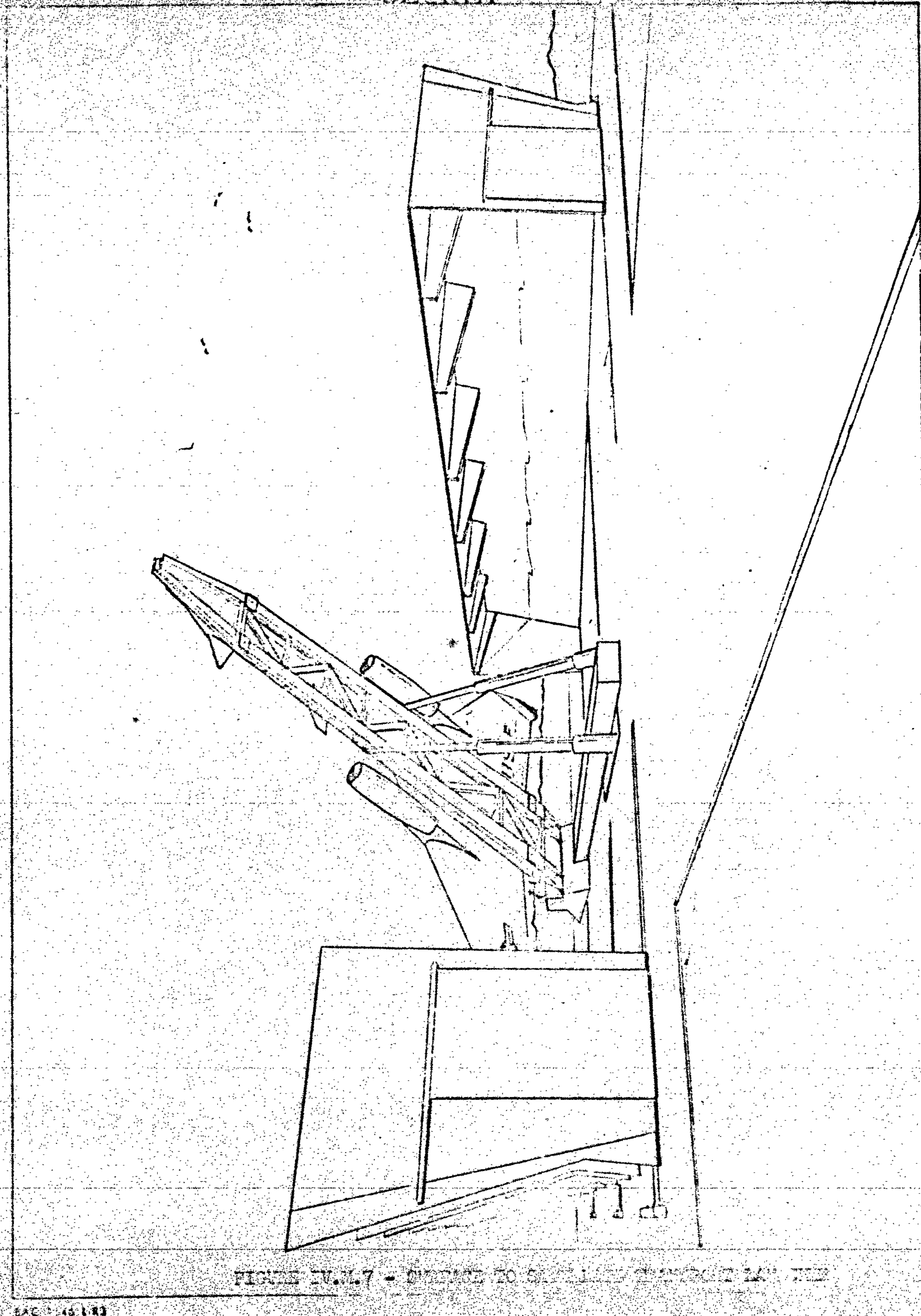


FIGURE IV.[illegible].7 - ENTRANCE TO [illegible]

Second stage engines, tankage, etc. are received in end-opening, metal containers. A visual inspection is performed and accepted components are transferred to a storage area. In accordance with the assembly operations schedule, the engines and other stage components are removed from their metal containers and transported on special dollies to the second stage build-up area where engines, tankage, interstage structure, etc. are assembled. After inspection and acceptance, the second stage is held in storage or transferred to the vehicle final assembly area as required.

Gliders are built up to the maximum degree practicable at the manufacturer's plant. The wings and equipment which cannot survive shipment after installation are shipped separately. After receiving inspection and storage, gliders are built up, checked out and routed to storage or the vehicle final assembly area.

The final assembly building is provided with parallel assembly lines. Booster stages are joined mechanically, followed by glider mating to the booster. The vehicle emerges from these operations on a strongback which supports it during subsequent ground operations. In the final assembly station, all systems integration is completed and an integrated systems test is performed. Vehicle final acceptance is based on this test. After acceptance, the strongback is placed on two sets of bogies, a tractor is attached and the vehicle is transported to the launch site.

When the vehicle is approximately in position, the shelter is closed and the strongback is attached to the erection mechanism.

The bogies and tractor are removed, umbilicals are attached, and the first stage is fueled by tank-truck with hydrocarbon fuel. Liquid oxygen and hydrogen are stored at the launch site in insulated tanks.

When a mission is alerted, the shelter is rolled back. Semi-automatic equipment pumps the cryogenic materials into the booster. After fueling is completed, liquid stores are topped off and the pilots are helped into their cockpits. Countdown is started and erection takes place during the final period before launch. Countdown functions are monitored by the pilots, by personnel in the launch control building adjacent to the launch pad, and by the launch coordinator who is located at the operations center. Any one of these men can abort the mission by not keying into the launch circuit.

The first stage booster lands at the base upon completion of its mission and is defueled and purged. It is then towed to the first stage maintenance area where other post-flight servicing is performed. Afterwards, the booster is recycled through the airborne vehicle maintenance, overhaul and checkout facility.

After landing, the glider is retrieved on a special handling vehicle and taken to the decontamination area. The pilot remains in the glider during decontamination to avoid exposure to residual radiation. The glider is returned to the industrial area for maintenance, overhaul and checkout prior to its next mission.

d. Ground Support Equipment and Facilities

Items of support equipment required after factory completion of components, but not directly associated with the operational firing aspects of a weapon, fall into this category. For the Satellite Transport System, these include the handling fixtures, dollies, beams, slings, work stands, special tools, major assembly test sets, functional checkout equipment, test set calibration equipment, special handling vehicles, decontamination equipment, shipping containers servicing equipment and cryogenic storage described in previous sections.

e. Ground Cooperational Equipment

This category of equipment is defined as those items and facilities directly involved in and required during a flight operation. The major items, in addition to the arresting gear, landing systems, and pilot access ladders, and autocollimator, include:

(1) Monitor and Control Equipment

This equipment located at the launch control room, provides for periodic checkout of the vehicle and launch site systems and indicates vehicle status. Faults are isolated to either the airborne vehicle or launch site equipment groupings. The pre-launch check and countdown procedure are controlled from the launch control center. The monitor and control functions are performed automatically while being monitored by a launch control officer. (The vehicle is provided with regulated ground electrical power and coolant during ground operation of its equipment).

(2) Erector

The launch erector is a hydraulically powered structure which is designed to receive the airborne vehicle-strongback combinations from the bogies. Prior to launch, hydraulic actuators erect the strongback into the vertical position, placing the airborne vehicle on its launch base. The strongback is then partially retracted and serves as an umbilical tower during launch operations. After launch the strongback is lowered and sent back to the base assembly on the transport bogies which have been replaced for this purpose.

g. Maintenance Concept

When a fault is detected by the launch site monitor equipment, its built-in fault isolation capability indicates whether the airborne vehicle or a particular launch site equipment grouping has failed. The faulty unit (vehicle or launch equipment) is replaced and sent to the base assembly area for repair. In the case of the airborne vehicle, the vehicle is defueled and purged before being moved to the final assembly building where it is functionally checked to determine the location of the malfunction. Units returned to the base assembly facility for maintenance are in general recycled through the assembly line in a reverse direction.

Post-recovery maintenance and major overhaul on the recoverable first stage boost is handled in accordance with North American Document ND59-44 "Operation Dyna Soar Recoverable Booster Studies". (Reference 2).

b. Personnel Support

Further study is required to determine the requirements for training and manning of this system. Approximate numbers of personnel required are:

Flight and Direct Operations and Maintenance Personnel (Includes satellite crews)	2090

5. RECONNAISSANCE SATELLITE VEHICLE

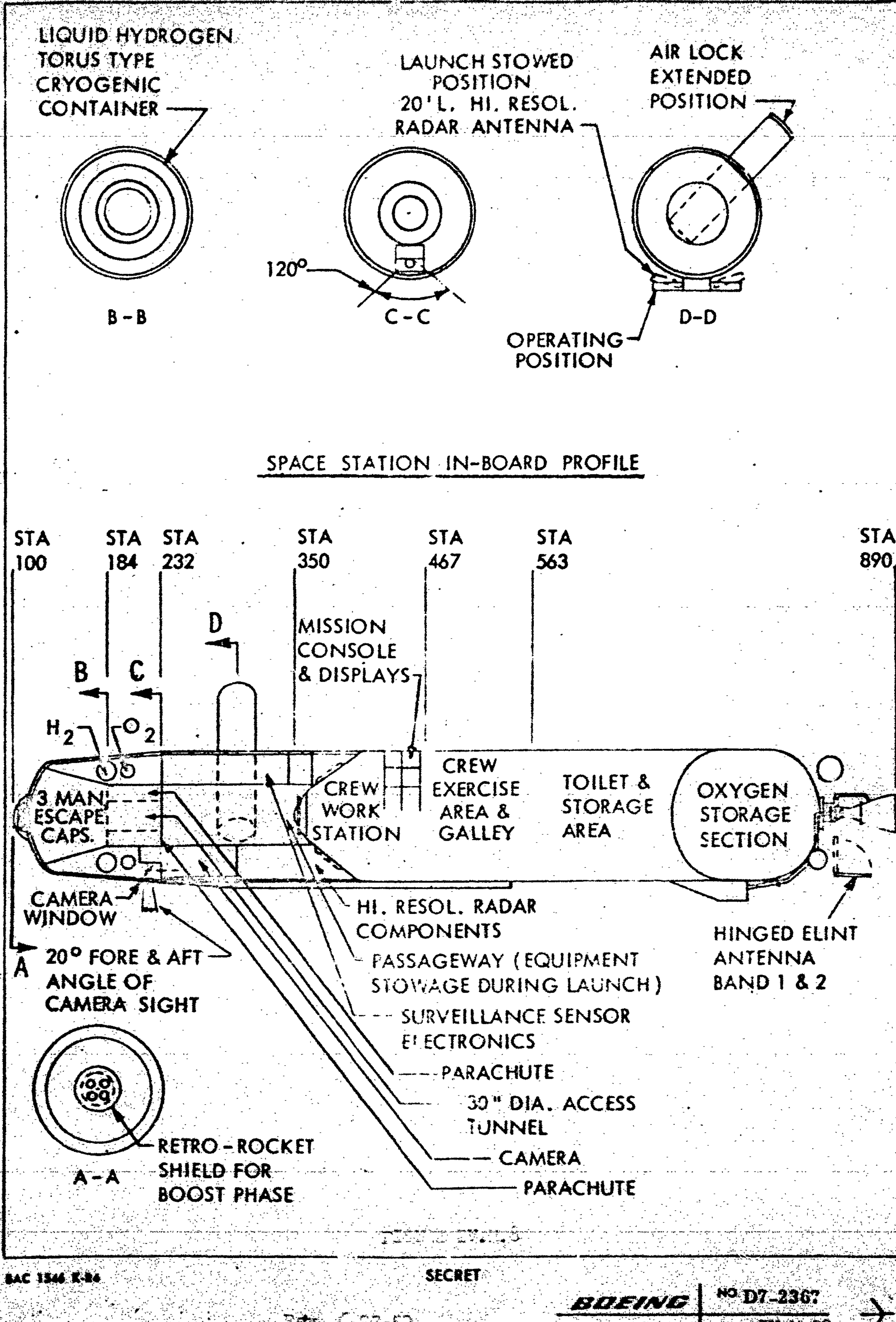
a. Vehicle Configuration

The space station (Figure IV.M.8) is comprised of a Final Stage Booster Case (burnout condition), an equipment bay approximately 10 feet long by 10 feet in diameter and a three-man escape capsule for emergency descent (ballistic trajectory). The normal method of crew return is in the resupply glider. The propulsion system will consist of a recoverable first stage and one subsequent stage. The three-man escape capsule will be used in case of damage to the space vehicle from meteorites or possible enemy action.

b. Final Stage Booster Section

The second stage of the booster will be a portion of the space station payload. It will be converted to living, recreational, and work quarters by the crew after reaching orbit. The fuel section of the booster case will be purged to expel fumes and then sealed and replenished with an atmosphere containing O_2 and N_2 from cryogenic supplies in the equipment bay.

The liquid-oxygen section of the Final Stage Booster, after fuel burnout, is used for gaseous storage of oxygen to provide an emergency source to permit maintenance of pressure long enough for the crew to take emergency measures in case a compartment leak develops. Oxygen is


LIQUID HYDROGEN TORUS TYPE CRYOGENIC CONTAINER
B - B
LAUNCH STOWED POSITION 20' L. HI. RESOL. RADAR ANTENNA
120°
C - C
AIR LOCK EXTENDED POSITION
D-D
OPERATING POSITION
SPACE STATION IN-BOARD PROFILE
STA 100
STA 184
STA 232
STA 350
STA 467
STA 563
STA 890
D
B
C
MISSION CONSOLE & DISPLAYS
H2
O2
3 MAN ESCAPE CAPS.
CREW WORK STATION
CREW EXERCISE AREA & GALLEY
TOILET & STORAGE AREA
OXYGEN STORAGE SECTION
CAMERA WINDOW
HI. RESOL. RADAR COMPONENTS
HINGED ELINT ANTENNA BAND 1 & 2
A
20° FORE & AFT ANGLE OF CAMERA SIGHT
PASSAGEWAY (EQUIPMENT STOWAGE DURING LAUNCH)
SURVEILLANCE SENSOR ELECTRONICS
PARACHUTE
30" DIA. ACCESS TUNNEL
CAMERA
PARACHUTE
RETRO - ROCKET SHIELD FOR BOOST PHASE
A - A

metered to crew quarters through a pressure regulator. Pressure will be maintained at 8.29 psi, equivalent to a 15,000-foot altitude.

c. Crew Quarters

A rest station, exercise area, toilet and sanitary facilities and galley are provided within the crew compartment (Figure IV.8). The toilet and rest areas are partitioned (using fuel tank baffles) for privacy. The forward end of the Final Stage Booster contains a 48-inch diameter sealed entrance door for access to the equipment bay, air-lock entry or escape capsule. Crew quarters contain galley provisions consisting mainly of food and liquid storage and toilet facilities, including plastic bags for waste material. The latter will be disposed by ejection to space through an ejection lock. To induce a relaxed sleeping position, a restraining net is provided for the crew member to maintain body contact with the internal structure of the crew quarters. The webbing will be attached to rings which are installed during the fuel tank fabrication. Crew quarters will also afford exercise and work areas. Equipment for galley and crew quarters will be stowed in the passageway of the equipment bay during boost. This equipment will be installed in the Fuel Tank section after reaching orbit.

d. Work Station

The forward portion of the crew quarters will be used as the work station. Items requiring crew control or sur-

veillance are: High-Resolution Radar, IR Missile Detection, Elint (Electronic Intelligence), Photography, Wide-Band and Narrow-Band Data Links, Flight Control Electronics (Flywheel Inertial Control), and UHF Transceiver. Displays and communication equipment are of the plug-in type for ease of installation in crew quarters.

e. Equipment Bay Section

(Internal Arrangement)

A five-foot diameter passageway connects the crew quarters with the escape capsule. This passageway is used for storage of the equipment and display items that will be installed in the crew quarters when in orbit. The passageway is also used for stowing the air-lock entry tube. The entry tube is used for cargo and crew exchange with the logistics carrier. Air-lock size is controlled by largest equipment item to be exchanged in orbit. Electronic equipment and spares are installed on rails about the passageway external surface for easy access and maintainability. Cryogenics, water, environmental equipment and other supplies are installed in the equipment bay area.

f. Escape Capsule Section

The dual purpose escape capsule will serve as a three-man emergency descent capsule and as a crew vehicle during boost. The re-entry face of the escape capsule acts as a particle shield while the space station is in orbit. The three-man capsule is an extrapolation of the Project Mercury capsule, modified to accommodate the additional

occupants. The crew will be arranged in the capsule to face forward during boost and aft during re-entry to minimize the effects of gravitational forces.

Equipment and environment in the capsule are of the emergency type for minimum weight. A parachute, for low-speed stability and capsule recovery, is cooled during re-entry by water trapped in a wicking blanket. Pitch, yaw and roll jets are provided for capsule orientation prior to re-entry. Thrust to escape the space station is provided by separation rockets in the parachute end of the capsule. An emergency communication system plus a marker beacon are provided in the capsule. Retro-rockets in the nose capsule provide reverse thrust to decelerate prior to re-entry.

An alternative escape capsule using the winged principal incorporated in the DS-I could be installed in place of the ballistic type or the satellite could be designed so that the transport vehicle remained until the next re-supply vehicle arrived.

g. External Arrangement Of Sensor Equipment

Surveillance sensors on the outside of the vehicle include a 20-foot, high-resolution radar antenna running lengthwise and covering portions of the equipment bay and crew quarters section and a photo-reconnaissance camera window allowing a lateral downward angle range of 120 degrees and longitudinal downward angle range of 20 degrees for the

photo camera mirror. Electronic Order of Battle antennas for bands 3, 4, 5, 6 and 7 are flush-mounted near the bottom periphery of the equipment bay adjacent to the front-end IF and detector package. This will keep wave-guide connections as short as possible. Antennas for bands 1 and 2 are located in the booster nozzle area and are hinged and stowed at 90 degrees during boost and extended when orbital altitude is reached. Two small detectors and preamplifier packages are plugged into bands 1 and 2 antenna circuits and are located in the aft end of the crew compartment. This location allows easy access and replacement of preamplifier packages. The alternate Technical Intelligence system which consists of heavier and larger electronic equipment uses identical antenna arrangement as required for EOB system. The wide-band and narrow-band data-link antennas are flush-mounted in the exterior surface of the equipment bay. The sensor for IR missile and aircraft detection can be extended from the equipment bay section and can be rotated for complete antenna coverage.

h. Accessory Equipment and Environmental Control

The vehicle as proposed for a 200 nautical mile orbit requires an average secondary power output of 3.35 KW and a peak output of 8.32 KW to meet all equipment power demands. Results of the accessory equipment study indicates that the secondary power could be supplied by either

hydrogen-oxygen fuel cells or by a system using sun oriented solar cells.

The use of a solar cell system would substantially reduce the amount of expendables required to re-supply the satellite but the problem of assembling the large number (approximately 200,000) of solar cells in a package that can be readily unfurled and oriented in space has not been solved. Until this problem is solved, hydrogen-oxygen fuel cells could be used as a source of power without making the system unwieldy.

Crew compartment and equipment cooling is provided by a fixed weight radiation system. Vehicle atmosphere is processed by chemical means to remove carbon dioxide and water vapor.

Installation of the solar power system and improved environmental control methods as they become available would enable either the re-supply vehicle to be made smaller or make it possible for the same vehicle to re-supply two satellites per trip.

i. Flight Control

A vehicle in space is subjected to attitude perturbation torques from many sources. The sources of some of these torques are:

(a) Earth's magnetic field;

(b) Earth's electric field;

(c) Earth's gravitational field;

(d) Gravitational field of celestial bodies;

(e) Solar radiation pressures;

(f) Vehicle electromagnetic radiation pressures;

(g) Atmosphere drag;

(h) Meteorite bombardment;

(i) Vehicle internal moving masses;

(k) Rotation of reference coordinates;

(l) Expulsion of mass from the vehicle.

The magnitude of these torques is critically dependent on the vehicle design and trajectory. Therefore, torques useful for stabilization can be enhanced and undesirable torques can be reduced by careful vehicle design. The design an attitude-control system, a detailed study of these torques must be made.

A study of the perturbation torques listed above shows that they can be classed as either impulse-accumulative or zero-averaging, with time depending on the attitude control requirements of the vehicle and on the averaging of the time period chosen. Minimum control system power requirements result when complete use is made of zero-averaging of impulses with time.

The attitude control system proposed for the global surveillance vehicle is designed to make optimum use of zero-averaging of impulses. An impulse storage system in the form of a flywheel inertial controller is used to main-

tain control accuracy during the time when impulses do not zero-average. For the accumulative torques, a jet-reaction controller is used.

The system operates in the following manner. An impulse imparted to the vehicle by a perturbation torque is stored in a flywheel until a countertorque is encountered and the impulse can be zero-averaged.

The impulse is transferred by a motor generator using a battery power scurce. Accumulated impulses are stored until the flywheel impulse capacity is reached. At this time, an impulse of the opposite sense is imparted by the jet reaction controller so the the cycle can be repeated.

A preliminary system design has been made based on the following vehicle and control requirements. The vehicle weighs 20,000 pounds with an inertia of 10^5 slug-feet^2 in the pitch and yaw axes and 5×10^3 slug-feet^2 about the roll axis. A jet reaction control system is used in the escape capsule for separation from the aft section of the vehicle, as a reto-rocket, and for re-entry stabilization. This system is also used by the surveillance vehicle in orbit. The moment arms are ten feet for the pitch and yaw and five feet for the roll axis. The control requirements are reduced to $\pm$ 10 degrees.

The altitude of the orbit is approximately 200 miles. High-control accuracy is required for only a portion of each orbit

when high-resolution sensors are being used.

It is estimated that the total control system weight is on the order of 250 pounds for 30 days orbit. Of this weight, 45 pounds is fuel that is expended (assuming liquid H_2 and O_2 for fuel), and 25 pounds is fuel stored in the capsule for use during escape. The flywheel inertial controllers are estimated to weigh a total of 60 pounds with an impulse storage capacity of 200 foot-pound-seconds about the pitch axes and 100 foot-pound-seconds about the roll and yaw axes. These requirements are based on an analysis of the major attitude perturbation torques. The major attitude perturbation torques are:

(a) Earth's gravitational field which is on the order of 0.04 foot-pounds for the pitch axes at 10 degrees from normal to the radii of the Earth;

(b) Rotation of reference coordinates which require on the order of 0.01 foot-pounds average for a ± 10 percent orbital eccentricity;

(c) Solar pressure which is on the order of 10^{-4} foot-pounds.

Two other torques of major concern are expulsion of mass from the vehicle and the vehicles internal moving masses.

Expulsion of mass from the vehicle is a concern if a chemical power unit is used. In this case the exhaust system is designed to provide control torques. It is

estimated that such a system would provide nearly all of the control required in orbit. Probably the most significant internal moving masses are the crew members. However, any impulses that the crew members impart to the vehicle will zero-average in a very short time. This means that unless the flywheel were very near its impulse capacity, or the vehicle were near its attitude limit, no fuel would be expended. It is desirable to minimize crew movement during reconnaissance when high-control accuracy is required.

To this point, we have assumed that the vehicle design does not deliberately or accidently enhance any of the perturbation torques. It is possible by vehicle design to increase some of these torques to magnitudes large enough for control use. One such possibility uses the torque on a current-carrying coil caused by the magnetic field of the Earth.

About two kilowatts of electrical power is required to produce one foot-pound of torque in a coil the diameter of the assumed vehicle. The coil contains about seven pounds of copper wire. If fuel cells were used for power, the equivalent specific impulse would be about the same as that of the jet-reaction controller. Additional studies are needed to evaluate the use of this control torque in conjunction with solar cells.

A disadvantage in using the magnetic field of the Earth is that only two axes of the vehicle effectively produce torque

at the same time, depending on the angular relationship between the vehicle axes and the magnetic flux of the Earth. This control scheme might be very effectively used on the pitch axes to provide trim torques. The pitch axes are most affected by the major perturbation torques.

j. Weight Data

Space Station: (Excluding Crew Quarters)

The preliminary weight statement for the permanent space station (excluding the crew quarters) is shown on the next page. Included are the reconnaissance sensor displays, galley and relief facilities, and other equipment that is stored in the space station during launch and transferred to the last booster stage propellant tank after the attainment of orbital flight.

Preliminary Weight Statement: Space Station (Excluding Crew Quarters)

GROUP	ESCAPE CAPSULE		EQUIPMENT BAY		TOTAL	
STRUCTURE		2000		1400		3400
RETROROCKET		200				200
Auxiliary Power	550		360		910	
Electrical System	180		450		630	
SECONDARY POWER		730		810		1540
ATTITUDE CONTROL		130		300		430
ELECTRONICS		100		3650		3750
ENVIRONMENTAL CONTROL		640		900		1540
Crewmen (3)	600				600	
Galley and Relief Equipment			150		150	
Seats, Consoles, Etc.	100		50		150	
Recovery Chute System	400				400	
Food, Water, Etc.			500		500	
Instrumentation	100		50		150	
Other Equipment	80		150		230	
CREW OPERATIONS		1280		900		2180
TOTAL SPACE STATION (Excluding Crew Quarters)		5080		7960		13,040

Total Space Station:

To the weights of the escape capsule and equipment bay must be added the weights of the invert final stage booster plus the secondary power fuel to obtain the total weight of the space station as shown below.

Escape Capsule & Equipment Bay	13,040 lb.
Orbit Injection Propellant	650 lb.
Vernier Propellant	100 lb.
Secondary Power Fuel	3220 lb.
Residual Liquid Oxygen	190 lb.
Invert Final Stage Booster	11,430 lb.
TOTAL SPACE STATION	28,630 lb.

Monthly Logistics Requirement:

To supply the Reconnaissance Satellite which the Surface to Satellite Transport must ferry the following items once each month:

Secondary Power Fuel	3220 lb.
Food and Water	460 lb.
Liquid Nitrogen	70 lb.
Breathing Oxygen	190 lb.
Pressurizing Oxygen	110 lb.
Replacement Equipment - Film, Tape, etc.	500 lb.
TOTAL	4550 lb.

IV. [illegible]

N. COMMUNICATION SATELLITE SYSTEM

1. Operational Concept

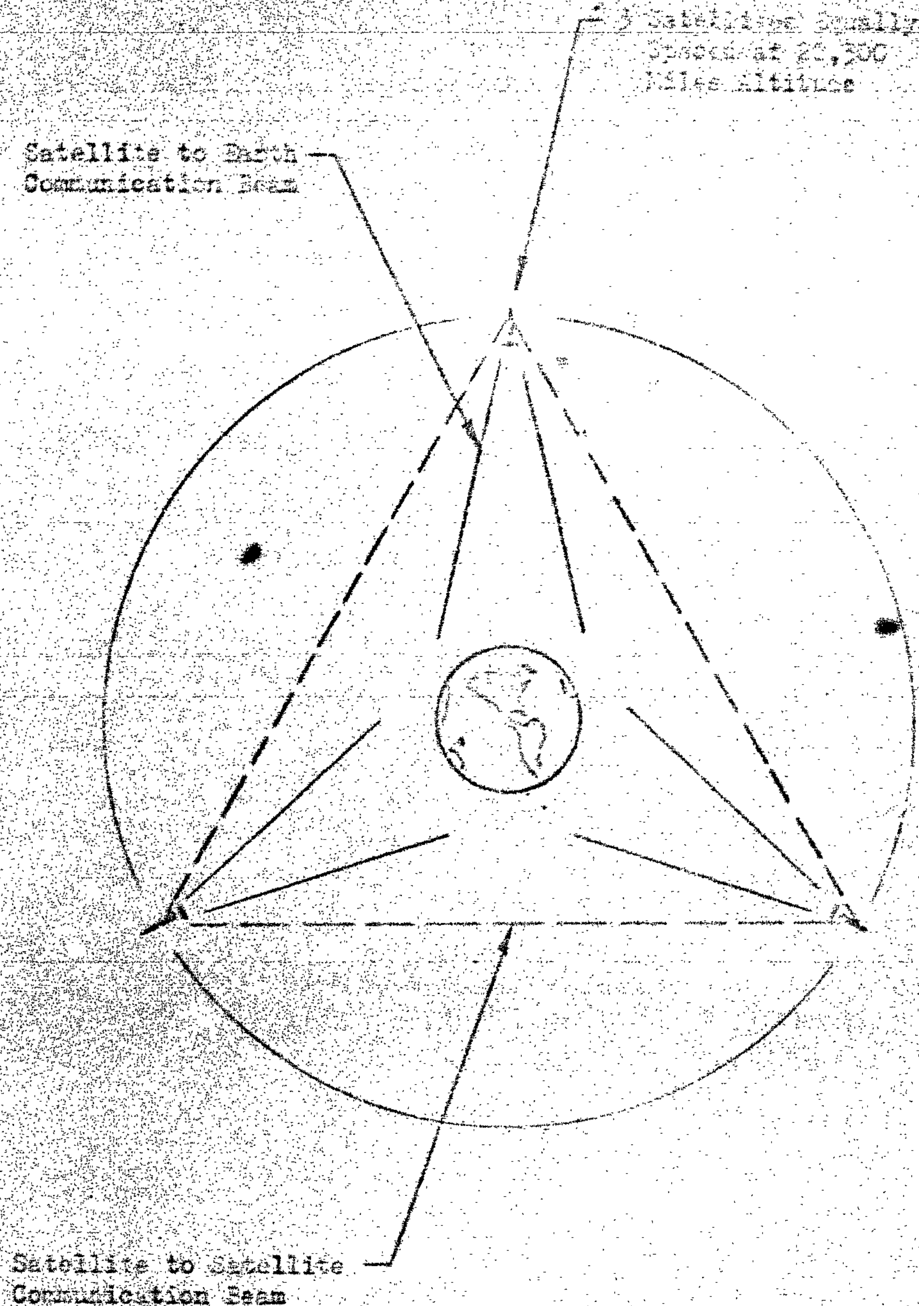
The Communication [illegible] of hyper-sonic [illegible], and inner space [illegible]

Three [illegible] placed in a 22,[illegible] The satellite vehicle [illegible] earth each 24 hours [illegible] communication vehicles [illegible] which is directed toward [illegible] point on earth [illegible] The 25° [illegible] vehicles up to a [illegible] surface. Three additional [illegible], in an orbital [illegible] plane will provide [illegible] Each vehicle is [illegible] beamed [illegible] Com-munication [illegible] by relaying [illegible]

A major [illegible] of this kind is the accuracy with [illegible] orbit. If the three vehicles are placed in the same circular orbit there will be [illegible] of antenna [illegible] It is necessary to orient the satellite [illegible] all of the antennas are aimed [illegible] is in an

elliptical orbit the antennas must be articulated and continuously aimed at their mating satellites. This additional motion complicates the system, and since it must function for a year becomes a possible source of malfunction. It also increases the amount of propellant required for stabilization during that period. The simplest system therefore is one well placed in a circular orbit.

The application of a glide re-entry configuration to the communication satellite vehicle is desirable from system servicing requirements. Upon command, a communication satellite can be de-orbited and guided to a landing at a selected site. Maintenance or recovery of system components can thereby be accomplished. Additionally, communication satellite vehicles are most probably retrofitted military vehicles. A number of military weapon systems presented in this document may be retrofitted to perform the communication satellite mission. The use of a reworked military weapon system for this application will lower the total system cost, from that required for an exclusive communication satellite system.



Recoverable Communication Satellite

Figure IV.N.1

2. **Configuration**

A large antenna directed toward the earth and two smaller ones directed at the other satellite stations comprise the antenna array of this vehicle. The large antenna is a metallized sector of a mylar balloon with four filled ribs in the antenna section to maintain shape of the antenna if the balloon punctures. The two small antennas are located in the glider with the electronics. Stabilization of the vehicle is by cold gas nozzles using stored nitrogen.

The attitude control nozzles of the glider are used for the orbital and re-entry period, however, the large tank of nitrogen required for orbital stabilization is external to the glider and is not returned.

The solar power system is a spherical balloon carried in an external pod. It is extended in orbit using the pod case for support arms. The entire system is jettisoned before re-entry.

The quantity of reaction control nitrogen is estimated on the basis of one year in orbit.

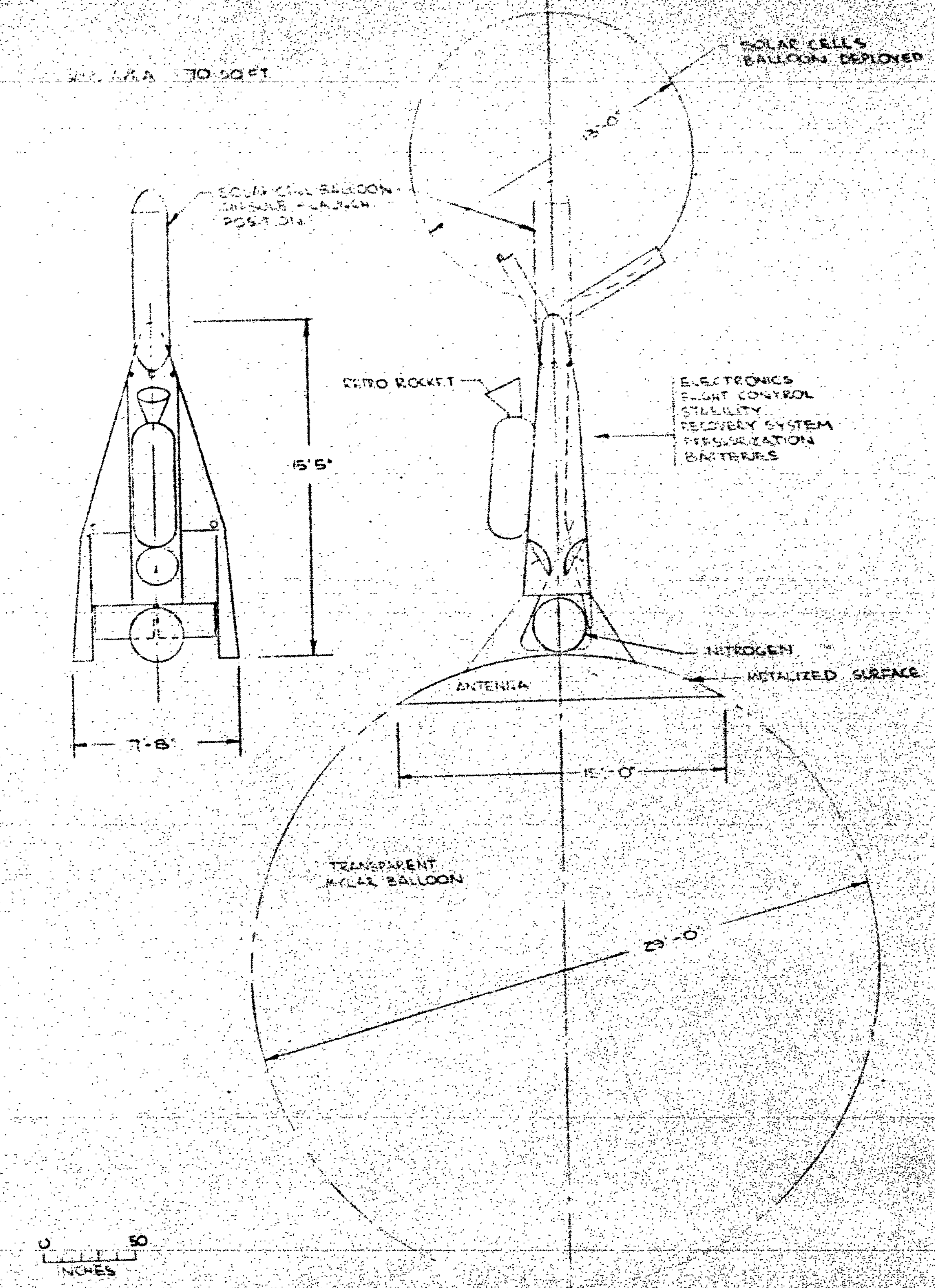


Figure 2

RECOVERABLE CO... ...CATION SATELLITE

3. Weight Statement - Recoverable Communication Satellite

Item	Weight - Pounds	
Wing	155	
Body	480	
Fins	80	
Control Surfaces	85	
TOTAL STRUCTURE		800
Auxiliary Power System	340	
Reaction Control System	50	
Hydraulic System	50	
Electrical System	25	
SECONDARY POWER SYSTEM		465
ENVIRONMENTAL CONTROL SYSTEM		260
ELECTRONICS		650
FLIGHT CONTROLS		50
RECOVERY SYSTEM		115
TOTAL GLIDER WEIGHT		2340
RETRO ROCKET INSTALLATION		1960
SOLAR CELL INSTALLATION		645
NITROGEN SPHERE AND LIQUID		255
ANTENNA INSTALLATION		40
TOTAL JETTISONED OR EXPENDED		2900
TOTAL "PAYLOAD" WEIGHT		5240

IV. MULTI-ORBIT WEAPON

P. MANNED ORBITAL COMMAND STATION

1. Operational Concept

The Manned Orbital Command Vehicle has as a primary function the operational command of strategic orbital weapons. The stations assume the strategic command of these weapons in event the ground based command stations are destroyed.

The vehicle contains planning equipment for computing and plotting the battle situation, communication equipment to contact ground based control centers as well as other command vehicles and orbiting weapons, and Reconnaissance equipment to gather intelligence information.

The vehicle is manned by a 10 man crew. These include a commander, communication specialists, command plotting specialists and reconnaissance personnel. The mission duration is 28 days.

The command station is made up of two parts, a winged recoverable vehicle, and a non-recoverable section for living quarters and equipment. The recoverable vehicle, is utilized only to recover men and the expensive equipment. Items not economical to recover may either be left in orbit to act as decoys, or be destroyed by allowing the section to re-enter the atmosphere where it is "burned up".

The command vehicle is placed into orbit by a recoverable first stage booster and a hydrogen - oxygen second stage.

The orbital altitude is approximately 150 miles to minimize the danger of artificial radiation created by nuclear explosions and to enhance resolution of the reconnaissance sensors.

Decoys are utilized to afford protection to the command vehicle and they will simulate as near as practicable the characteristics of the command station. Some propulsion is required in order to maintain similar orbital characteristics. Passive reconnaissance techniques are to be employed on the command vehicle and radar will be used only in case of emergency to avoid disclosing the true nature of the mission. However, equipment will be placed aboard the decoys to simulate the communication radiation of the manned vehicle. Space to space communications are to be transmitted at frequencies for which there are no atmospheric windows, thereby preventing ground based equipment from detecting these communications. The command stations are equipped with relay systems to insure world wide communications. Nine command stations at orbital altitudes of 200 miles are required to maintain round-the-clock command reliability and round-the-world signal relay capabilities.

2. System Configurations

General Performance

A vehicle configuration and inboard arrangement is shown on Figure IV.P.1.

The command station is launched in a "safe" trajectory where emergency recovery can be affected without exceeding the skin material temperature limits in the case of a premature thrust termination. Separation of the glider from the command canister is required during an attempted recovery.

A circular orbiting altitude of 200 miles has been selected as consistent with missile detection range requirements and reconnaissance equipment resolution capabilities.

Vernier rockets are attached to the aft end of the Command Station provide a velocity error correction to achieve a circular orbit after separation from the last stage.

Prior to re-entry the non-recoverable section attached to the glider is separated. Air pressure within the section provides the separation force.

General Arrangement

Externally the glider is similar to the manned, Orbital Reconnaissance Vehicle (Section IV.A.); however, it is larger. With the existing configuration a relatively light re-entry wing load of 24.5 pounds per square foot is experienced. However, there may exist a desirability for carrying-back to earth a considerable quantity of the more reliable, security items

of reconnaissance gear, and data recording equipment. On this basis a carry-back glider weight increase of 2,500 pounds could be tolerated without exceeding wing loading of 29 pounds per square foot. If later considerations dictate that a higher return payload is not desirable, then the glider size (wing area) might be deceased.

Reaction control nozzles are located in the glider nose and in the wings to provide the necessary forces required to maintain desired vehicle orientation with respect to earth during orbit. Generally, the command station will orbit with glider nose forward and directional antennae looking toward earth. Fuel containers, vernier rockets, and command system antennas are all located aft of the space canister, within the protection of the interstage structure during the boost phase. After final stage separation, vernier rockets and command antennas will be exposed.

An X-band, ground control approach antenna, and an automatic approach flare-out antenna are integral with the glider nose wheel landing gear.

Vehicle primary structure will follow the DS-1 determinate truss concept. Control of internal environment for a re-entry follows the DS-1 concept.

Internal Arrangement and Crew Accomodations

During boost and re-entry crew members are seated in a tandem arrangement in the glider compartment which otherwise when

occupied during orbit is used for an aisle way. The pilot flight panel is used as an orbital work station to monitor equipment operation. However, performance of reconnaissance and command tasks will be carried out at the command post in the rear of the separable section. A pressure bulkhead with pressure door, located at Station 600, separates the glider and canister. A rest station, exercise area, sanitary facilities, and galley are also provided in the canister. Toilet, galley and rest area will be individually partitioned for privacy and sound dissipation.

Makeup oxygen and nitrogen from liquid sources replenish the breathing air supply used by the man and lost by leakage. The environmental control system removes carbon dioxide, odors and water vapor.

Military Subsystems

Military subsystems will include:

(1) Strategic Command Data Links
(2) Orbital Bomb Command Link
(3) Integrated Situation Display
(4) IR Detection
(5) Elint
(6) Mapping IR, Radar, and Photo

Power Source

For re-entry the glider will utilize an Auxiliary Power Unit burning hydrogen and oxygen. All reconnaissance and orbital power will be obtained by means of fuel cells which produce electrical energy. These cells will be located in the aft end of the canister.

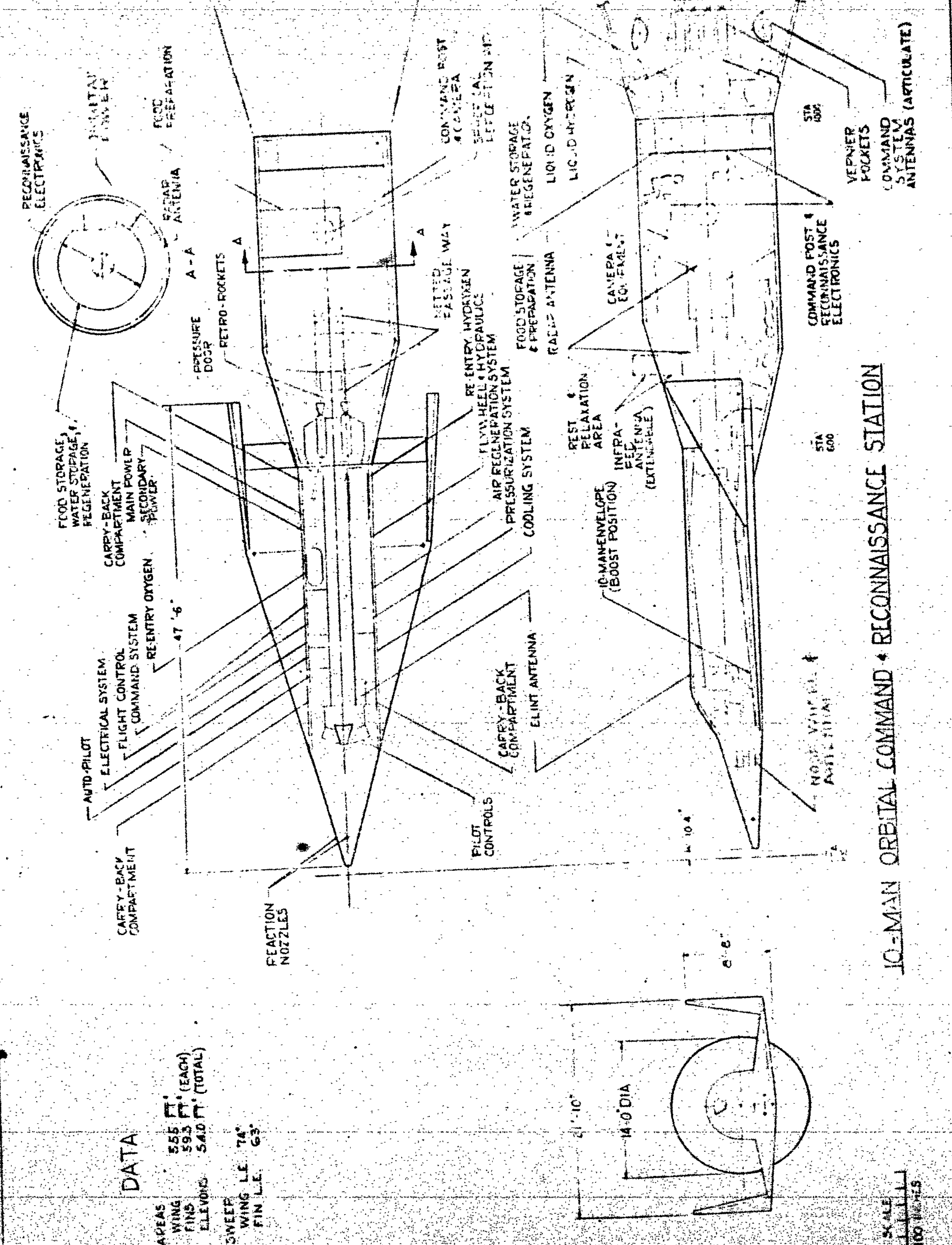

DATA
AREAS
WING 555 FT²
FINS 59.3 FT² (EACH)
ELEVONS 54.0 FT² (TOTAL)
SWEEP
WING L.E. 74°
FIN L.E. 63°
RECONNAISSANCE ELECTRONICS
FOOD STORAGE, WATER STORAGE, & REGENERATION
RADAR ANTENNA
FOOD PREPARATION
A - A
AUTO-PILOT
ELECTRICAL SYSTEM
FLIGHT CONTROL
COMMAND SYSTEM
RE-ENTRY OXYGEN
CARRY-BACK COMPARTMENT
MAIN POWER
SECONDARY POWER
47'-6"
PRESSURE DOOR
RETRO-ROCKETS
REACTION NOZZLES
NETTED PASSAGE WAY
COMMAND POST & CAMERA
RE-ENTRY HYDROGEN
FLYWHEEL & HYDRAULICS
AIR REGENERATION SYSTEM
PRESSURIZATION SYSTEM
COOLING SYSTEM
PILOT CONTROLS
ELINT ANTENNA
FOOD STORAGE & PREPARATION
WATER STORAGE & REGENERATION
RADAR ANTENNA
LIQUID OXYGEN
LIQUID HYDROGEN
REST & RELAXATION AREA
10-MAN-ENVELOPE (BOOST POSITION)
INFRA-RED ANTENNA (EXTENDIBLE)
CAMERA & EQUIPMENT
21'-10"
14'-0" DIA
8'-8"
10.4"
STA 600
STA 1000
COMMAND POST & RECONNAISSANCE ELECTRONICS
VERNIER ROCKETS
COMMAND SYSTEM ANTENNAS (ARTICULATE)
SCALE
100 INCHES
10-MAN ORBITAL COMMAND & RECONNAISSANCE STATION

Figure IV.P.1

Plotting Center

The problem of combat situational display demands exploration of alternative means of making three-dimensional battle situations available to the commander. Combinations of geometric displays and digital readouts are being considered.

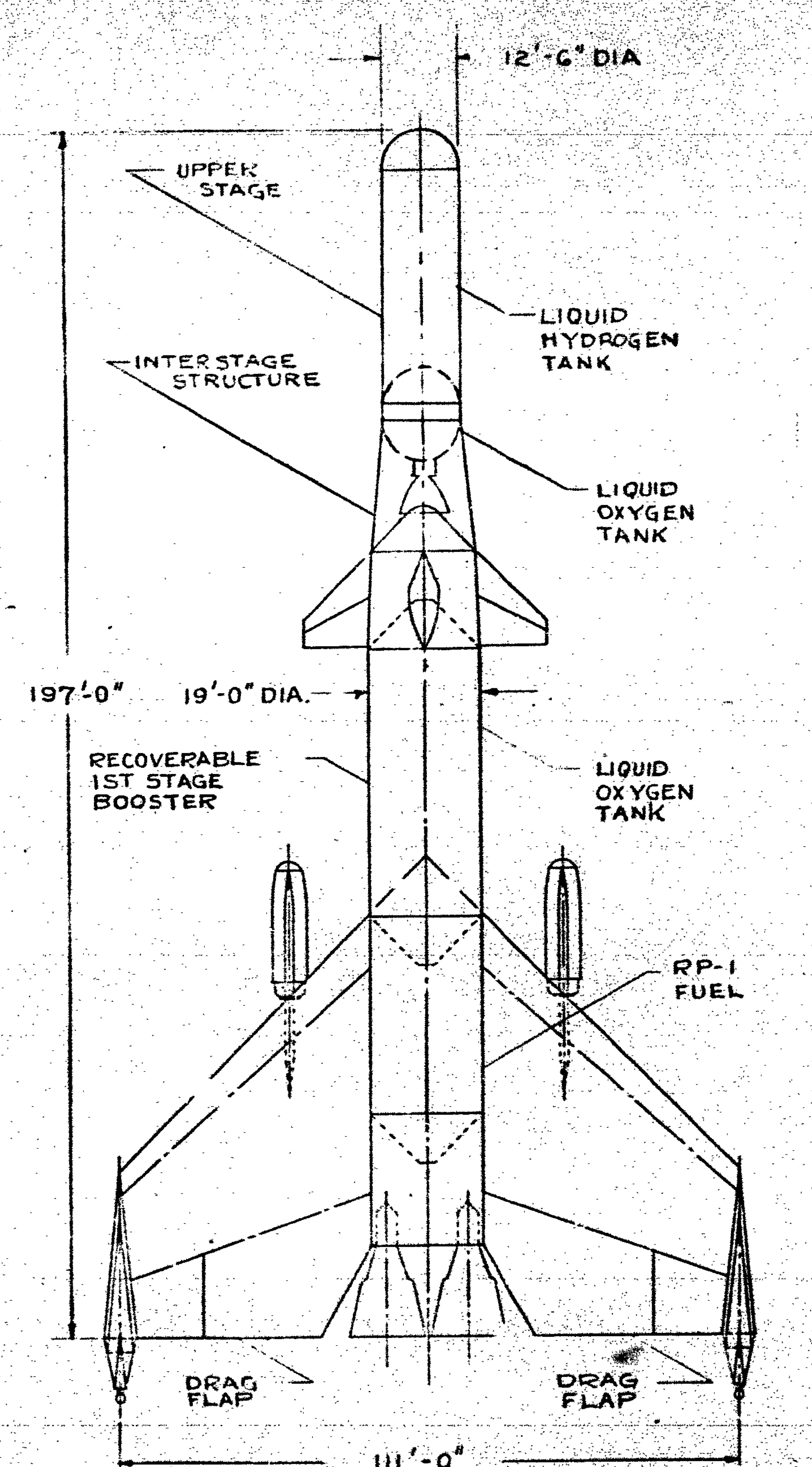
Booster System

The booster for the Manned Orbital Command Post Vehicle is a two stage booster (See Figure IV.P.2). The first stage is recoverable and utilizes liquid oxygen and liquid hydrocarbon propellants. The second stage goes into orbit with the glider and is expendable; it uses liquid oxygen and liquid hydrogen propellants. The second stage will be separated from the canister for use of command antennae and orbital corrections with vernier rockets. Section V provides more information on boosters.

The first stage attains a burnout velocity of 8,800 fps. The upper stage then has the capability of placing a 32,400 pound payload in a 200 N.M. altitude, circular, polar orbit.

Weight Statement

	Weight - Pounds
Glider and Cannister	32,400
Second Stage	
Burnout	46,500
Propellant	127,500
Start Burning	174,000
First Stage	
Weight Empty	220,000
Pilot	250
Trapped Rocket Propellant	11,600
Turbojet Fuel	43,000
Propellant	1,160,000
Launch Weight	1,608,850



12'-6" DIA
UPPER STAGE
LIQUID HYDROGEN TANK
INTER STAGE STRUCTURE
LIQUID OXYGEN TANK
197'-0"
19'-0" DIA.
RECOVERABLE 1ST STAGE BOOSTER
LIQUID OXYGEN TANK
RP-1 FUEL
DRAG FLAP
DRAG FLAP
111'-0"

FIGURE IV F-2

3. Ground Systems and Support

Ground system preliminary planning is based on the flight hardware description plus the following operational requirements and assumptions:

Utilization: Nine vehicles in orbit at all times; twenty-eight day mission duration.

Launch Rate: One vehicle every three days.

Reaction Time: As required to meet the launch schedule.

Vulnerability Allowable: Launch site hardening not required.

Recycle Time: Gliders fifteen days; first stage boosters nine days.

The vehicle force, ground system and personnel required are as follows:

Number of Bases: One

Force Size: Nineteen gliders; six recoverable first stage boosters.

Launch Sites: Three.

Personnel: 125 flight personnel; 1500 to 2000 ground system people.

The small force size, low launching frequency, and necessity for elaborate vehicle assembly, maintenance and launch facilities make a single base very desirable for economic reasons. Special provisions for on-base assembly and test of the non-recoverable crew station are required because its large diameter makes shipment of assembled units impracticable. On-base final assembly of gliders and second stage boosters is required for similar reasons. Due to the similarity of

the fundamental assembly and handling problems in both systems, the base organization, operations and facilities described for the manned orbital bomber, section IV E 5, may be applied to this concept.

IV. MULTI-ORBIT WEAPONS

Q. ORBITAL SCIENTIFIC LABORATORY

1. Operational Concept

The Orbital Scientific Laboratory system is obtained by modification of military, hypersonic boost-glide vehicles to perform scientific missions. The particular existing military vehicles to be used depends upon the experiments to be performed, the data to be gathered, the need for manned research, and the test equipment required to support the test. Several military vehicles are adaptable to these missions; they are: Satelloid Reconnaissance System (Section III.B) Orbital Reconnaissance Vehicle (Section IV.A) and Orbital Bomber (Section IV.K).

It is difficult, at this time, to suggest what the scientific laboratories of five to ten years hence will be most interested in studying. Each new breakthrough in scientific knowledge and technology has opened new areas of mystery. The achievement of flexible, piloted flight at orbital velocities outside the earth's atmosphere, with controlled landings may provide for scientific advancement no less significant than the development of nuclear energy. Experiments in space can utilize accessible cosmic radiation which is far more powerful than that available with the largest earthbound accelerator or reactor. It permits astronomical or spectroscopic study over the entire electromagnetic spectrum instead of the narrow optical and radio windows accessible from the earth, and without the turbulence and cloud conditions which limit "seeing" from ground observatory. While the range of scientific investiga-

tions that could be undertaken is nearly limitless, the following studies are among those which could utilize this Ortital Scientific Labratory system.

1. Biological experimentation on animals, plants and humans which are exposed to the environmental conditions of space vehicles, including zero gravity.
2. A study of ultra-violet, X-ray, infra-red and cosmic ray emissions from the sun, planets and outer space. After an initial mapping of the skies, some of the ultra-violet, X-ray and infra-red detectors will monitor the activity of the sun. Other ultra-violet detectors will monitor the Lyman alpha radiation from the hydrogen outside the atmosphere. Data taken during solar activity can be compared with data obtained from a magnetometer located on a long boom protruding from the vehicle) and the cosmic-ray detectors to see what correlation exists. In addition to measuring the cosmic-ray flux by means of counters, it is desireable to expose emulsions outside the vehicle by a remote handling device to obtain a knowledge of the various nuclei of which cosmic-rays are composed. These emulsions would then be examined micro scopically when returned to earth.
3. An investigation of micro-meteorites using erosion gage detectors, microphone detectors and capture plates. The capture plates are exposed outside the vehicle, by means identical to the exposure of the cosmic-ray study emulsions, and returned to earth.

By examination of capture plates, the composition and penetration of micro-meteorites can be ascertained.

4. A study of both the strength and the variation, with altitude, of the earth's magnetic field utilizing magnetometers.

5. An investigation of the charge on the vehicle as well as the charge density in the region through which the vehicle passes. The charge on the vehicle is measured by means of field mills and by modified, retractable, Langmuir probes, which extend beyond the surface of the vehicle.

6. A study of the variation of electon density with altitude above the region of maximum density of the F_2 layer, by means of ionospheric sounding equipment. Ionospheric sounding is performed by a method analogoud to the "virtual height" method used on the the surface of the earth. A slowly varying frequency between 1 to 10 megacycles, or alternatively several fixed frequencies within this range, is propagated downward in pulses and the elapsed time to pulse return noted. From a knowledge of the altitude of the vehicle and the time delay between transmitted and received pulses it is possible to establish the "virtual depth" of the ionosphere at that point at the particular frequency being investigated. The electron density is then deduced at that points where the reflection of the particular frequency occurs.

7. Studies of the earth's atmosphere; albedo for light, chemistry, and winds and turbulence.

8. Study of the earth's shape

9. An investigation of the hydrogen atom emission and absorption spectrum from outside the atmosphere.

10. A study of the source and energy spectrum of particles causing the aurora.

11. A study of paths followed by incoming particles in the earth's magnetic field and an investigation of the possibility and mechanism of acceleration of the incoming particles.

12. A study of the energy behavior and balance of the earth.

13. Further investigations of the Van Allen radiation belt.

14. A study of the sun's corona as an energy source.

15. A study of weather patterns and phenomenon.

16. Astronomical studies using a 12 to 20 inch diameter telescope for photographic, photometric and spectro scopic studies over a wide spectrum range. (Studies of the sun, planets, and other astral bodies, as well as to the earth is accomplished) With a servo positioned co-elastatic mirror which controlled by the experimeter. The mirror is locked on to any desired target or directed to scan in a prearranged pattern.

While much of the data obtained during these investigations could be telemetered to earth upon command, however, items such as cosmic-ray emulsions, micro-meteorite traps, photographic

film, laboratory animals, and personnel require return to earth. The hypersonic glide vehicle is particularly suited to the re-entry requirements because of its maneuver capabilities which permit safe delivery at a pre-selected site, minimum return times and low re-entry forces. Military hypersonic boost glide vehicles can be retrofitted to a scientific laboratory configuration to pursue space research investigations.

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IV. MULTI-ORBIT SYSTEMS

B. ORBITAL WEATHER OBSERVATION STATION

1. Operational Concept

The Orbital Weather Observation Station system is an application of Dyna Soar technology and provides a stable orbiting platform from which synoptic weather data is gathered and transmitted and weather research studies conducted. A glide re-entry vehicle is boostered into a 125 nautical mile altitude polar orbit for a two week mission period. Both synoptic and research observations are made during the mission period with a high resolution camera, a photometer, infrared sensors including a spectrometer, radar, a magnetometer, and television. While some data is transmitted to ground stations by data link during the mission, bulk data and atmospheric samples are returned for processing and analysis at the completion of the mission.

Analysis and the correlation of data from a number of weather missions is used to establish, if possible, a global weather pattern and improved means of weather prediction over U.S. and USSR controlled areas. Synoptic observations made are:

1. Cloud formations - a high resolution camera and television equipment are utilized to obtain storm patterns and hurricane warnings;
2. Earth's surface and the cloud top temperatures are determined by the infra-red equipment;
3. Water content and the freezing level of cloud formations, including thunder heads, by means of the radar sensor.

A number of weather research projects will be undertaken among which are:

1. Correlation of solar activity with weather changes by means of solar radiation measurements in the ultraviolet spectral region;
2. Changes in the earth's surface (ground, water, snow, ice and clouds) reflectivity by means of albedo and heat balance measurements;
3. Determination of the mechanisms of global air circulation by observation of incoming short wave and outgoing long wave radiations;
4. Measurement of ionospheric winds with a magnetometer;
5. Correlation, if possible, of cloud formations with the rate of incidence of meteoric dust.

This application of a satellite vehicle serves to provide data which has significant application to military planning. However, the vehicle described in Section IV.A for the two week reconnaissance mission can be outfitted for the weather observations.